GILL'S
TECHNOLOGICAL & MICROSCOPIC REPOSITORY;

OR,

DISCOVERIES AND IMPROVEMENTS

IN THE

Useful Arts,

BEING A CONTINUATION OF HIS TECHNICAL REPOSITORY.

By THOMAS GILL, *Patent-Agent,*

AND DEMONSTRATOR IN TECHNOLOGY, ON THE APPLICATION OF SCIENCE TO THE USEFUL ARTS AND MANUFACTURES;

UPWARDS OF TWENTY YEARS A CHAIRMAN OF THE COMMITTEE OF MECHANICS IN THE SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE, ADELPHI, LONDON; HONORARY MEMBER OF THE ROYAL PRUSSIAN ECONOMICAL SOCIETY OF POTSDAM; AND A CORRESPONDING MEMBER OF THE ROYAL BAVARIAN POLYTECHNICAL AND AGRICULTURAL SOCIETIES OF MUNICH.

VOL. I.

LONDON:
PRINTED BY W. SPIERS,
399, OXFORD-STREET;
EDITED AT GILL'S PATENT AGENCY & COMMISSION OFFICE,
125, STRAND, NEAR TO SAVOY AND WELLINGTON STREETS,
PUBLISHED BY THOMAS HURST, EDWARD CHANCE, AND COMPANY,
65, ST. PAUL'S CHURCH-YARD;
AND SOLD BY THE FOLLOWING OPTICIANS, viz:—
CAREY, STRAND; BANCKS, BOND STREET; WATKINS and HILL, CHARING CROSS;
P. CARPENTER, REGENT STREET; WEST, FLEET STREET;
BATE, POULTRY; and JONES'S HOLBORN:
ALSO BY THE FOLLOWING BOOKSELLERS, viz:—
LONGMAN and CO. and BALDWIN and CO. PATERNOSTER ROW; W. SPIERS, OXFORD STREET; LIMBIRD, STRAND; and GRIFFITHS, WELLINGTON STREET, LONDON:
LIKEWISE BY TREUTTEL and WURTZ, PARIS and STRASBURG:
and DOBSON, PHILADELPHIA:
AND BY OTHER PRINCIPAL OPTICIANS, BOOKSELLERS AND NEWSMEN IN TOWN & COUNTRY.

1830.

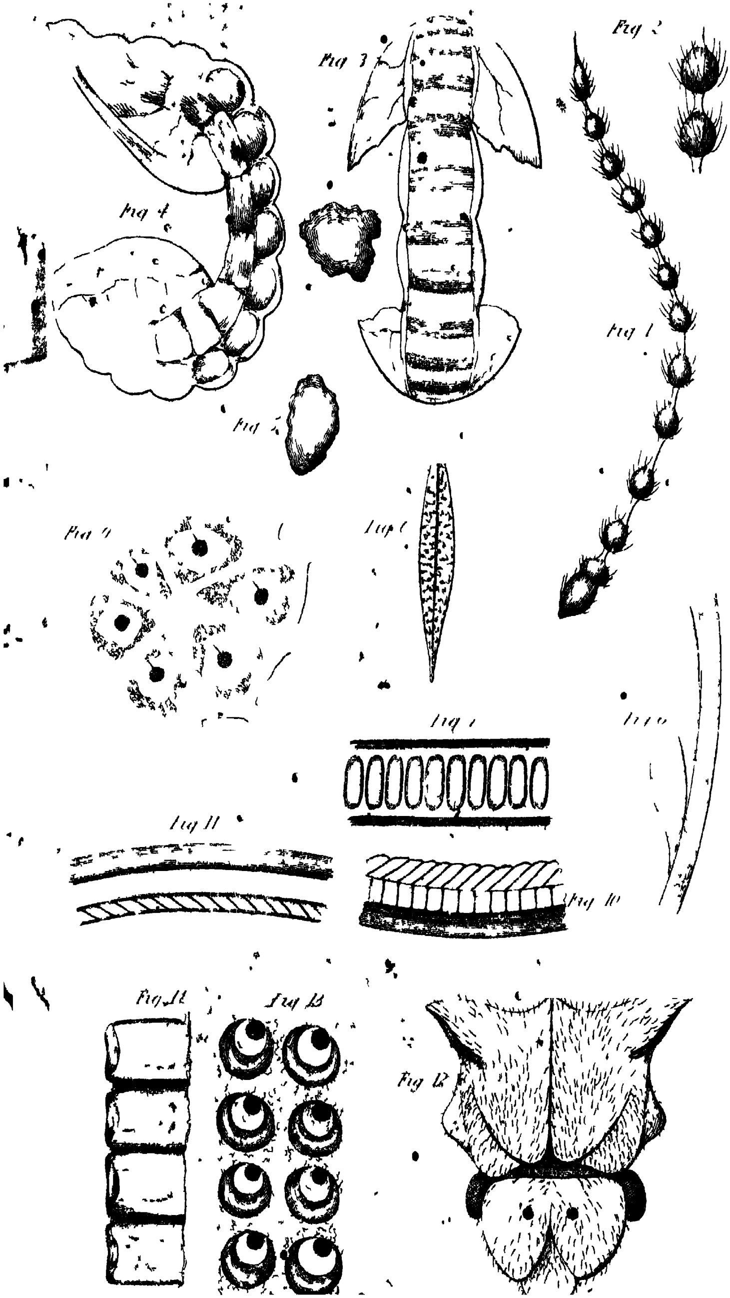

Fig 1
Fig 2
Fig 3
Fig 4
Fig 5
Fig 10
Fig 11
Fig 12
Fig 13

GILL'S
TECHNOLOGICAL & MICROSCOPIC REPOSITORY.

I.—*On the Microscope.* *By* THOMAS CARPENTER, *Esq.* *With Remarks and Additions.* *By the* EDITOR.

WITH A PLATE.

DEAR SIR, *London, December 8th,* 1829.

I FEEL great pleasure in complying with your request, of sending for your examination a few microscopic objects, from the collection in my possession. Within the ten talc sliders you will find the following objects, which, I trust, will afford you much gratification, in tracing out, under your microscope, the numerous and diversified characters with which they are adorned, the beauties of which escape the unassisted sight. The antennæ of various insects afford numerous interesting objects, as a sample of which, I send some from the curculio, carabus, cimex, and the midge-fly, which latter insect is so exceedingly minute, as to be nearly invisible to the eye, and yet it contains most exquisite workmanship.

There is also, in the same slider, a few seeds and seed-vessels from a fern. The various parts of fern will furnish you with many objects. I have sent you a few small portions of the leaves, on the under side of which you will perceive numerous clusters of seeds, covered over with a fine skin or membrane, full of pores or air-vessels for the purpose of admitting air to the pods containing the seeds, some of these skins are within the talc slider just mentioned. These pods appear to the naked eye to be the seeds, instead of which, each pod, small as it is, contains numerous seeds, which, by the assistance of the microscope, may be distinctly seen.

The minuteness of these seeds is astonishing. These may be distinctly seen on some pieces of card, on which I have placed some pods, which, bursting, have discharged their contents on the surface of the card. On a piece of the fern leaf, is also the cast skin of an aphis, covered over with seeds by the bursting of the pods. In the selection from the leaves, I have sent specimens of the seeds in their various stages towards ripeness, and in which you will find much to admire. I have also enclosed, between slips of glass, numerous seeds, and seed-cases from the same plant, to be viewed as transparent objects; also a few of the smaller leaves, in which you will perceive very fine reticulations, together with a few transverse sections, cut from the roots and branches of the plants. These are very beautifully marked, and form grand objects indeed, for the lucernal or solar microscopes. In the talc sliders before mentioned, are also dissections from various parts of the sheep tick, the rostrum of the *cimex lectularius*, scales from a butterfly, hairs from the cast skin of a species of dermestes. The lower lip and palpi of the cock-roach, some curious scales taken from the feelers of a small hunting spider, hair from a field-mouse, also some hair from a rat, with the eggs of the louse which infests that animal adhering to the hair, minute scales from some of the smaller moths, various ticks taken from pigeons, the insect described in Adams on the microscope, as the lobster insect, the proboscis of a flea displayed, a very minute acarus, that is frequently found running very nimbly over the leaves and fruit of the currant tree, various cast skins from the aphides, eggs from the flea of the cat, among which are also seen some of the caterpillars in the act of coming forth, and others quite out, leaving the empty shells, as curious transparent objects. Within the last talc slider, No. 12, there is the cast skin of a cimex, farina of the major convolvulus, farina of the holly-oak, antennæ of a gnat, parts of the tympanums or drums of a fly, which are situated under the wings of the insect. The down attached to the various species of

the thistle, affords fine objects for the microscope; these you will have frequent opportunities of collecting. I send you a curious specimen of one of the foreign seeds, with the down attached to it; in appearance it resembles a shuttlecock. Some of this down, I have also placed between slips of glass, and which forms an excellent object. I also send you the wing-cases of a cimex, placed between talc in a box slider. And, between slips of glass, there are wing-cases of other species of cimices, together with the head and proboscis of one species dissected. The genus cimex affords an abundant field, from which you may derive most splendid objects for your microscope; the workmanship or characters displayed in some of the wing-cases, are highly interesting. Between these glasses are likewise some specimens of farina from various flowers, sent you, in order that you may examine them as opaque objects, by placing a piece of black card behind them; which method I think you will prefer to viewing them as transparent objects, as you will then have the advantage of seeing the colour of the farina as well as the characters, in viewing them as opaque objects. Between another slip of glass I have enclosed four wing-cases of one of the common cicadas. Many other wing-cases of this genus are also elegant microscopic objects. The fucus or sea-weed, affords numerous fine objects, a few specimens of which I have also placed between glass slips. These I received from Brighton, and when exhibited under the lucernal or solar microscope, they will produce a fine effect. Amongst the various objects herein enumerated, there are some whose characters are very difficult to define; but, as I before-mentioned, I have the loan of an excellent achromatic object-glass from my friend Mr. W. Tulley, so I shall feel happy in placing them before it, in order that you may observe the interesting characters contained within them.

With the foregoing, I also send you two or three species of our common cicada, usually termed frog-hoppers, from some fancied resemblance to the colour and shape of that

animal in miniature. The larvæ or grubs of this insect discharge from their bodies, upon the branches and leaves of plants, a kind of frothy matter (called by the country people cuckoo-spit), in the midst of which they constantly reside, probably for shelter against the rapacity of such stronger insects as would otherwise prey upon them. Nature has also afforded this kind of defence to these insects, as their naked and soft bodies might otherwise be very easily injured; perhaps, also, the moisture of this froth may serve to screen them from the sultry beams of the sun. On removing the froth, the grub is discovered underneath; but it will not remain long uncovered. It soon emits a fresh froth, that again hides it from the eye of observation. It is in the midst of this froth that the larva goes through its metamorphoses; first into a crysalis, and then into a winged insect. This may be observed by any person who is careful enough to watch when the froth begins to subside a little. At this time, he must put the insect under a glass, together with its leaf. The froth evaporating away to a white film, fixes the creature to the leaf; soon after this, the fly may be seen, first putting out its head, and afterwards by degrees its body. As soon as the fore part is out, a small protuberance will be perceived on each side, which, every moment growing larger, will soon appear to be the wings of the fly, unfolding by degrees. In about a quarter of an hour, the whole change is completed; the fly is liberated, its wings are extended over its body, and the fine silver-like case of the larva, with all its legs and other apparatus, will be left behind. The perfect insect is of a brown colour, and has on the upper wings two lateral whitish spots. It is very common in meadows, &c., and is so agile, that when attempted to be caught, it will sometimes spring to the distance of two or three yards. The species of insect I have just described, I have now sent, together with the cast skin, and also other species, and various dissections of the rostrum, showing the instruments for piercing and sucking the juices of the plants, from

which it derives its sustenance; you will also observe the manner in which the rostrum is attached to the head of the insect, resembling, in appearance, the trunk of the elephant; in short, these little creatures will be found, on examination, to be very singular and curious in every part.

I also send you the lacquey-moth *phalæna nuestria;* this insect is instructed, by an instinct given to it, to deposit its eggs, not only in a place of safety, and where there is a sufficient quantity of food to support and nourish the larvæ immediately on their breaking the shell, but also to cement them, with great symmetry, round the smaller branches of trees, with a strong glue, which connects and binds them together; and this connection is further strengthened by the moth filling up all the intervening spaces between the eggs with a very tenacious substance, which, by the action of the air, soon becomes as hard as stone, and thus are they protected from injury by the weather, or any other cause. Several of these eggs I send to show you the manner in which they lie embedded in this glutinous substance. Others I have cut into various sections, and placed them on slips of card. The insides of the shells appear as fine in colour as if coated with mother of pearl; and in some of the other eggs, which are cut open, may be seen the young caterpillars coiled up. It is not easy to describe the beauty of these objects when viewed under the opaque speculum; the regularity with which they are placed, the delicacy of their texture, and the beautiful and ever varying colours which they present to the eye, give the spectator a high degree of rational delight.

Lastly, I send for your inspection a very singular insect, the *notoxus monoceros;* the peculiarities of its figure are very remarkable; the head is of a dark colour, and appears to be hid or buried under the thorax, which projects forwards, like a horn; and the whole insect is curiously covered with hair. I imagine it to be very scarce, having

seldom met with it; the specimen I now send I found on a flower in the garden.

In my next letter, I will endeavour to point out other objects, equally curious with those which accompany this paper.

I remain, dear sir,
Your obliged friend,
THOMAS CARPENTER.

To T. GILL, *Esq.*

Remarks and Additions. By the EDITOR.

In plate I. fig 1 is a magnified view of one of the beautiful antennæ of a midge-fly; it is composed of a series of balls, with necks connecting them together, and the balls are surrounded with fringes of hairs. Fig. 2 represents two of the balls, with their necks and hairs, magnified still more.

Fig. 3 is a back view, and fig. 4 a side view, of one of the capsules of a fern, exhibited on a highly magnified scale; and in which the spring which causes the capsule to open and discharge its seeds is seen. Fig. 5 are magnified views of two of these seeds.

Fig. 6 is a magnified view of one of the singular scales taken from the feelers of a small hunting-spider. It is covered all over with a kind of rough granulations.

Fig. 7 is a highly magnified view of a portion of one of the hairs of a field mouse, as viewed in Mr. William Tulley's achromatic microscope, with the assistance of a greyed glass, to cut off the aberrations of the light. Its very curious markings are well displayed.

Fig 8 exhibits two of the eggs of the insect which infests the rat, adhering to a part of one of its hairs, as shown on a tolerably large scale.

Fig. 9 is a magnified view of part of one of the wing-cases of a cicada. It is very curiously marked, appearing as so many intersecting paths, surrounding patches of green, each of which has a mount within it, and a brown spot in the centre of the mount.

Figs. 10, and 11 are highly magnified views of the internal and external parts of one of the three instruments inclosed in the proboscis of a cimex. They are, however, so long, that it is quite impossible to introduce them on a sufficiently magnified scale, in the limit of the plate.

Fig. 12 is a magnified view of the head of a cicada, the upper part of which has two projections in the form of ears. Its two compound eyes, one on each side; and its two stemmata or single eyes, in the front of its head, are distinctly seen.

Fig. 13 is an external view, and fig. 14, a section of several eggs, of the lacquey moth, represented on a large scale.

On viewing the Contractile Power of the Blood in Curdling.

In our last volume, page 337, we mentioned this singular appearance of the globules of the blood in curdling, as resembling heaps of similar coins, sliding one beneath another, when the heaps are thrown down; and as was kindly exhibited to us by Mr. Lister. Since then, we have found that an excellent mode of viewing this appearance is, by placing a small drop of fresh blood upon a slip of glass, and instantly covering it with a very thin slice of talc. The globules of blood will thus be enabled to assume this interesting situation without the obstruction caused by the pressure of another slip of glass upon them, as described in our former communications upon this subject. A high degree of magnifying power, is however, necessary to be employed, such as that afforded by a single lens, of the sixtieth of an inch focus, for instance.

On viewing Decomposed Glass, as a Transparent and Opaque Microscopic Object.

Our readers must no doubt have frequently seen window-glass, partly decomposed by the action of ammonia, in the windows of stables, and become covered with a pearly coat. This coat is capable of being scraped off with a knife, in the form of scales or thin lamina, and has a beautiful ap-

pearance under the microscope, both as a transparent, and as an opaque object. As a transparent object, the laminæ appear coloured yellow, orange, red, purple, and sometimes blue, owing to the refraction of the light passing through them. On wetting them, all the colours disappear, but are again restored, when the glass becomes dry. Sometimes pieces of broken black quart bottles may be found which have undergone this partial decomposition, and their colours are even more splendid than those of the window glass.

(To be continued.)

II.—*Recollections of his Father, the late Mr.* THOMAS GILL. *By the* EDITOR.

MR. GILL was the eldest son of a Lancashire watch and clock tool manufacturer, who removed with his wife and family from the neighbourhood of Prescot, the original seat of this manufacture in England, to Birmingham, where, however, he soon died, leaving his widow and six young children to lament his loss.

The Lancashire watch and clock tool manufacture was originally established in this country by a colony of Swiss Huguonots, who fled here to avoid a religious persecution, and brought with them the knowledge they possessed in many valuable arts and manufactures; and, indeed, it is to them that this country is also indebted for the introduction of some of its most important branches in the silk, woollen, and other trades; and there certainly were no persons so well calculated to afford instruction in the very difficult art of working steel in perfection. In fact, at this present time, the Swiss workmen possess superior methods of treating iron and steel, known only to themselves; and we daily see instances of their great skill, in the construction of their watches, musical seals and boxes, and other exquisite mechanical performances.

Educated in the knowledge acquired by the Lancashire watch and clock tool makers, Mr. Gill was thus enabled

to carry improvements into whatever articles he manufactured, and he possessed such an ardour, and so enterprizing a spirit, that he succeeded in greatly improving the qualities of all those articles which bore the stamp of his name. The Editor well recollects, that in his infancy (now upwards of half a century since), his father was established as a tool, file, and saw manufacturer, and in the practice of employing both Lancashire and Sheffield workmen, in making the numerous articles comprised in those different branches. And, even at the present day, smooth files of his father's making, when but a youth, are yet in use, and are valued by their possessors at more than their weight in gold, from their superior quality of not clogging in their teeth, as such files generally do. So, likewise, the saws of his early manufacture, continued perfect to the end of their duration, and what had, perhaps, originally been a hand-saw, finally ended in becoming a key-hole saw, from the continual filing away of its teeth in sharpening it, thus narrowing its original breadth, and yet its quality continued perfect to the last.

It would be impossible for the Editor, at this distance of time, to recollect the manifold articles which his late father was in the habit of manufacturing in his early days; amongst others, however, he is able to mention steel elastic plated spurs, things then unheard of, the plated spurs usually made being clumsy heavy things, too stiff to bend; whereas his were light and pleasant to wear; and the test of their goodness was their branches being capable of springing or bending until their extremities met, and then flying back again to their original extent, when set at liberty.

In his business of saw-making, he had occasion to harden pit-saws of considerable length, and they being made of cast-steel, the greatest nicety was required in uniformly heating them from end to end previous to quenching them in the hardening liquid. This difficult task he accomplished by erecting a reverberatory furnace of sufficient

length, having a fire-place at one end of it, and the flame and heated air from which, passing along the horizontal flue or working part of the furnace, was then again returned in another flue, formed above the furnace, a thin layer of earthen tubes or quarries, supported upon iron cross-bars, forming the separation between the flues ; and from thence the heated air and flame passed up the chimney. In this way, and notwithstanding the fire was at one end of this long furnace, yet the flame being made to pass twice through it, the heat was rendered nearly uniform, and its equality of temperature was still further insured by means of small air-registers, built in the external wall of the furnace, towards that end of it where the fire was placed, and which had iron doors to them, and by opening which doors the excess of heat towards the fire-place could be abated when necessary, always however carefully shutting them again previously to heating the saws in the furnace, in order to prevent their oxidation by the air, which would otherwise have entered at the register doors. A hanging-door at the opposite end of the furnace to that in which the fire was made, could be raised and lowered when necessary, in order to place the saws in the furnace to heat them, and to withdraw them again to quench and harden them.

A reverberatory furnace of the above kind is useful in many other branches of manufacture besides saw-making, and indeed his father frequently employed it for uniformly heating other cast-steel articles ; in particular, he had made numerous steel ribs, intended to stretch the feathers forming the wings and tail of an artificial bird, made large enough to contain a man within its body, and who, by means of proper machinery, could put the wings and tail into motion. This contrivance was the work of a projector, previous to the use of balloons, and who thought he should thus be able to cause the bird to mount into the air, carrying the man with it. We need hardly say, that beyond making an exhibition of his bird at the Pantheon, in this metropolis,

and where it astonished crowds, who flocked to see it wave its wings, and move its tail, it totally failed in its object, and the projector, after endeavouring to ascend from the roof of a barn, and of course falling to the earth, fled away himself, leaving the costs of constructing his bird unpaid for! However, this afforded the Editor's father an opportunity of evincing his great skill in the difficult art of working, hardening, and tempering cast-steel, in the manufacturing of the above-mentioned steel ribs, some of the largest of which were upwards of nine feet in length, and yet weighed not more than nine ounces each! These ribs were made square, and tapered away gradually from their thickest parts, or where they were united to the machine, to their ends; and yet were so perfectly hardened and tempered, that they were as elastic as a waggoner's whip; and, in fact, his father frequently caused the trees in his garden to be beaten with them, to exhibit their wonderful perfection to his visitors, without in the least degree injuring their quality!

Mr. Gill was also one of the earliest improvers of the cotton-spinning machinery, and for some time carried on that business on his own account with great success, having at an early period spun cotton threads as fine as one hundred and eighty hanks to the pound. However, some of his early friends became desirous of uniting in partnership with him in this undertaking, and, in consequence, the machines were increased in number, and part of a large building, erected as a steam-mill, at Birmingham, was filled with them. The undertaking would, no doubt, have finally proved exceedingly advantageous to all the parties concerned; but, in consequence of some great failures taking place amongst the Lancashire cotton-spinners, his partners became alarmed, and insisted upon disposing of the whole of the machinery by auction. At the sale, it was purchased by the late celebrated Mr. James Watt, for his friend David Dale, and, no doubt, became the models for his celebrated Lanark cotton-works. Mr. Watt, after completing his

purchase, stated, that it was the finest machinery of the kind that he had ever seen in his life. A high compliment indeed from one so eminently qualified to judge of the value of machinery.

Mr. Gill was early honoured by the friendship of, and was continually applied to by, the late Matthew Boulton, Esq., the founder of that magnificent establishment, the Soho, near Birmingham, in all cases where his superior knowledge in the treatment of steel was deemed useful, and this before Mr. Boulton had united in partnership with Mr. Watt; and even after that event, he was constantly in the habit of furnishing the cast-steel, which was formed into springs by their workmen, suitable for their uses in their steam-engines, and which were afterwards hardened and tempered by him, and never failed to perform their destined offices. On one occasion he was employed to make the steel springs used in actuating a machine in the nature of the catapulta, and which was contrived by a Frenchman, named Loyaute, to throw hand-grenades. This machine was put to trial in Mr. Boulton's pleasure-grounds, at the Soho; and the Editor having placed himself behind it, in a convenient posture to watch the path of the grenade about to be thrown from it, was nearly killed by an iron compound pulley-block, or sheave, which was employed in drawing down the arm of the catapulta, by means of an iron chain; and the chain breaking, the pulley-block was projected with such force backwards, as to strike off the arm of a tree immediately above the Editor's head.

One of the most important pursuits which Mr. Gill ever engaged in, was his retrieving the reputation of English swords, which, in the year 1783, had fallen into such deserved ill-repute, that an English officer would not trust his life to the hazard of the probable failure of his English sword-blade, upon any consideration whatever; although, only a century preceding, James the Second passed an act expressly prohibiting, under severe penalties, the importa-

tion of swords from Germany, or any other nation; a clear proof, that, at that period, the English swords were sufficiently good to be relied upon. However, in the year 1783, a petition was presented to the Lords of the Treasury, by the London sword-sellers, praying leave to import sword-blades from Germany duty free, under the degrading idea, that those of English manufacture were of an inferior quality. But as a friend to the manufactures of England, the late Duke of Norfolk, then Earl of Surrey, and one of the lords of that board, wrote a letter to a gentleman of Sheffield, Mr. Eyre, dated October 1, to the following purport:

"You will please inform those whom it may concern, that a petition hath been this day presented to the Treasury, praying permission to import swords and sword-blades from Germany, duty free, on account of the inferior quality of English blades. I should be very happy that any ingenious manufacturer of Sheffield would supply me with such information, both as to price and quality, as would enable me to remove so disgraceful a reflection on English ingenuity." The business of sword making being, however, more immediately within the province of the Birmingham manufacturers, Mr. Eyre sent Mr. Gill an extract from his lordship's letter, who thereupon, in December of that year, presented a memorial to the Right Honourable the Lords of the Treasury, stating that sword-blades could be made by him of as good a quality as those from Germany, and praying that the comparative goodness of those of both countries might be examined into. In consequence of which, a letter was written by Mr. Sheridan, to his grace the master general, and board of ordnance, and in answer thereto it was remarked, "that the board of ordnance does not furnish any swords to the regiments of dragoons; but they apprehend the error has arisen from the application of colonels of regiments of dragoons, who supply swords for their own corps; nevertheless, if their lordships wished an investigation of the matter, and they would direct a number of foreign swords to be sent to the

Tower, the board would give directions to have their goodness examined and compared with those of Birmingham."

This answer was sent the 7th of January, 1784, and there the business ended. No foreign swords were ever sent to the Tower for the above purpose, nor was any trial of their comparative goodness ever made; and it was not till the year 1786, that Mr. Gill obtained the object of his pursuit, though he had made repeated and fruitless attempts for that purpose. For, on an order for ten thousand horsemen's swords being issued by the East India Company, which was divided indiscriminately amongst English and German manufacturers, Mr. Gill, being still anxious for the comparative proof, presented a petition to the committee of shipping of the East India Company, requesting that all the swords of the different countries and manufacturers might be proved by a test, so as to ascertain the difference of their qualities. This produced an order for that purpose, and a resolution that none but such as on inspection and proofs stood that test, should be received.

Accordingly, when the swords were sent to the company's warehouse, they underwent an examination by a test or machine, recommended by Matthew Boulton, Esq., of the Soho, for trying the quality or temper of the sword-blades; namely, by forcing the blade into a curved state, and which reduced its length of thirty-six inches to twenty-nine and a half inches only, from the point to the hilt. The result of this trial proved, that Mr. Gill had two thousand six hundred and fifty swords received, and only four rejected.

That of the German swords, fourteen hundred were received, and twenty-eight rejected, being in the proportion of thirteen to one of Mr. Gill's.

And that of the other English swords, only two thousand seven hundred were received, and one thousand and eighty-four rejected!

It was owing to the parsimony of the London retailers of swords, that the English swords fell into disrepute; the fact was, they employed unskilful workmen, and bought

goods of an inferior quality. To corroborate this fact, it may be necessary to relate a case in point:—A London dealer having executed a commission for swords for General Harcourt's regiment of dragoons, prior to its going to North America, in the war of the revolution of that country, was called upon by the General on his return to England, and upbraided by him in the severest language of reproach, for having supplied his troops with swords of so base a quality, that they either broke to pieces, or became useless, in the first onset of an engagement, by which many of his brave soldiers were unworthily slaughtered, and his own person exposed to the most imminent danger. In this distressed predicament, the contractor applied to Mr. Gill, who had never before supplied him with any sword-blades, in consequence of another regiment wanting some at that time, to know at what price he could render swords of such a quality as to bear what he, the contractor, called a severe mode of trial, namely, striking the sword with violence upon a large flat stone. But Mr. Gill, in answer, told him he thought it by no means so severe as it ought to be, to determine properly the real quality of swords; and that he would engage to serve him with such as should stand a much severer test, at an advance of only nine-pence for horsemen's, and six-pence for small swords, more than was given to other makers for those of an inferior quality. In fact, besides subjecting his sword-blades to the test of bending them in the manner above-mentioned, he caused them to be struck flatways upon a slab of cast-iron, and edgeways upon a cylinder of wrought-iron, frequently a piece of a gun-barrel, which they often cut into two parts. Nay, so exceedingly tough were they, although made of cast-steel, that, after cutting a gun-barrel asunder, he would frequently wind one of them around it in the manner of a ribband, without its breaking; and indeed the greater part of the blade would recover its original straightness, the part nearest to the point only remaining in a coiled state.

The result of this great success was, that he was very

frequently applied to for his superior sword-blades, even by German officers, who preferred them to those of the manufacture of their own country. Neither did he content himself with improving the quality of his sword-blades, but he likewise studied their embellishment, both by blueing and gilding them in the most elegant manner, and by embossing them, and in which he employed the talents of the first-rate artists.

Besides his business of a sword-cutler, Mr. Gill was also a large contractor for the supply of ironmongery stores to the office of ordnance, and which also included the supply of tools and materials for the use of the royal military artificers; and, in fact, in one year in particular, he supplied such to the amount of upwards of one hundred thousand pounds sterling! And, indeed, so voluminous were the accounts, that it cost the life of one of his most expert clerks to get through them. In fact, the ordnance granted him imprests to the amount of fifty thousand pounds, in one instance, and thirty thousand pounds in another, to enable him to execute those large supplies.

He was also the first gunmaker in this country who set up, as it is termed, or put together, musquets, carbines, and pistols, for government use, out of London. During the French revolutionary war, however, the ordnance finding the supply from the London gunmakers to be insufficient for the extensive demand for fire-arms, determined that they should likewise be set up in Birmingham, from whence indeed the locks, barrels, brass-work, &c., had always been procured; but the arms were set up under the inspection of viewers, in the Tower of London. And accordingly he wrote to the Editor at Birmingham, whilst he himself was in London, desiring him to wait upon the Birmingham gunmakers, and to apprise them of the wishes of government on this head, and likewise to inform them that he was determined government should not be disappointed, and that unless they would undertake the task, he would himself become a gunmaker. They, however, were so much

alarmed at the thoughts of setting up fire-arms under the rigid inspection of the view-masters, having merely been makers of musquets for the African trade, and the merchants, and of ordinary pistols and fowling-pieces, that although their workmen were out of employment, owing to the war putting a stop to their trade, yet not one of them would venture to embark in the undertaking. On this, Mr. Gill brought down into the country with him an inspector and view-masters from the Tower; a proof-house and view-rooms were constructed in the vicinity of Birmingham, upon the borders of a navigable canal, and he commenced the important object, in which indeed he was greatly assisted by the care and diligence of the inspector, and proof and view masters, his task being chiefly confined to the financial department; and after having thus readily fallen into this important pursuit, and succeeded for several years in affording complete satisfaction to the inspector and his officers, and consequently to the board of ordnance itself, the Birmingham gunmakers at length began to rouze themselves, and endeavour to share in the work; and with this intent, to endeavour to get back their workmen from Mr. Gill; this, however, government would not permit, and they were therefore under the necessity of procuring others. About this period also, the lease of a powerful forge and water-mills, situated in the midst of the gun-barrel welders, having expired, Mr. Gill took a lease of them, and thus completely established himself as a manufacturer of gun-barrels also. However, in process of time, the other Birmingham gunmakers entered into the business of setting up fire-arms, and, during the late wars, have rendered the most essential services to government.

The forge and mills above-mentioned were constructed upon the usual plan, of the water-wheels running as fast as the water could drive them, and, consequently, to the great waste of their power. They were, likewise, at the end of a long lease, in such a state of dilapidation, that they required nearly an entire renovation, and, accordingly, were taken upon a repairing lease for the long period of ninety-nine

years. The Editor then prevailed upon his father to adopt, in the construction of the new water-wheels, the scientific principles established by the experiments of the celebrated Smeaton; namely, that in overshot water-wheels, the peripheries should not move with a greater speed than three feet per second. This slow motion being however so very different from the usual speed of such water-wheels, it was determined that the novel experiment should be first tried by the removal of a small water-wheel, of only twelve feet in diameter, and over which, when the mill-pond was full and the head and fall was twenty feet, the greater part of the water was thrown, without much of it entering the buckets; in short, it was the most wasteful water-wheel in the works. In place of this, another water-wheel, of sixteen feet in diameter, was substituted; and instead of being an over-shot, it was what is termed in this country a back-shut, and in the United States, a pitch-back, water-wheel, the water being laid upon it behind, near to its top, and its motion being in the same direction with that of the water flowing from it, so that, in time of floods, it was less obstructed by the back-water, or tail-water. When this wheel was completed, it was found that all the water it required would have passed through a hole an inch square only, and that instead of moving at the rate of three turns per minute, as intended, it made two and a half revolutions only, and yet it performed its work, that of actuating two pairs of large forge-bellows, most perfectly. The success attendant upon this first experiment, led Mr. Gill to construct two other water-wheels, the one of sixteen feet in diameter, and five feet in breadth, with deeper buckets than usual; and another of the same diameter, and ten feet broad; and by dividing the work of boring and grinding gun-barrels, and grinding and polishing sword-blades, between these two water-wheels, the expenditure of the water was very greatly economised, and the mills also rendered much more powerful.

(To be continued.)

III.—*On the singular Whirling Motion of a Watch-glass, without any apparent cause. Communicated to the* EDITOR, *by Mr.* CHARLES WHEATSTONE, *of Conduit Street.*

MR. WHEATSTONE first saw this curious effect at the shop of a Lapidary, in Edinburgh, about a year and a half since; but it has only recently been recalled to his notice.

If a watch-glass be placed, with its convex side downwards, upon a plate of glass wetted with water, and the plate be inclined in a proper manner, it will soon begin to gyrate, or assume a circular movement, in addition to the sliding one, occasioned by inclining the glass plate; and this circular motion may be continued at pleasure, by so changing the inclination of the glass plate, as to cause the watch-glass to continually traverse along the edges or sides of the plate. Nay, by dexterous management, it may even be caused to run up hill, whilst the circular movement of the watch-glass continues, owing to its momentum, or *vis inertia*.

No satisfactory cause has as yet been given of this curious effect; the water is attracted in a circular form, underneath the centre of the watch-glass, and it is thought, exerts a tangential influence upon it, as it is carried along, and thus causes it to assume this circular motion.

The lapidary had formed the Scotch topaz into portions of solid spheres, and pretended that they must be necessarily employed to produce the above singular effects; a common watch-glass, however, is fully sufficient for the purpose.

IV.—*On the Union of Mechanical Skill with the Highest Attainments in Science. By Dr.* THOMAS P. JONES.

(*Continued from Vol. V. page 374.*)

THE manufacture of pottery had remained in England in a comparative rude state, until Mr. Josias Wedgewood,

about sixty years ago, effected in it a complete revolution. The porcelain used by the opulent, was imported from France, to the great disadvantage of the English manufacturer. Wedgewood was the son of a potter in Staffordshire, and, from his early youth, was employed in his father's business. His education was very limited, and his patrimony small; but, his mind was vigorous, and he soon manifested its superiority, by the improvements which he introduced.

By him was invented the Wedgewood, or Queen's-ware, which not only excluded the foreign manufacturer from the market, but also supplied a large quantity for exportation, and gave a new spur to trade, extending the business far beyond all former example. He made himself acquainted with chemistry, instituted a vast number of experiments, and discovered various materials, applicable to his business, forming many new species of earthen-ware, and porcelain, both useful and ornamental. As he acquired wealth, he liberally expended it for the promotion of the arts, particularly in their application to his own business. The figures on his cameos and intaglios, rivalled the productions of ancient Greece. The Portland vase, found in the tomb of the Emperor Severus, he imitated, with perfect success, in form, in colour, and in the grace and beauty of the figures with which it was enriched.

By his means the district which he inhabited became the centre of a vast population, and a place of great wealth. He lived highly esteemed for his moral and intellectual qualities, the associate of men distinguished for genius and science, and died universally regretted, in the year 1795.

Sir Richard Arkwright, the youngest of thirteen children, whose parents were in indigent circumstances, was originally a country barber; but although he enjoyed neither the advantages of fortune, or of education, nature had endowed him with a fine mechanical genius, and an untiring ardour in the pursuit of his objects; these qualities enabled him to rise above the numerous obstacles resulting from obscu-

rity, from poverty, and from prejudice; procuring for him both rank and title, and enabling him to accumulate a princely fortune. His first recorded mechanical effort, was in the pursuit of the phantom, perpetual motion; a phantom which has misled a great number of men, possessing more mechanical genius than scientific information, and has sometimes beguiled those who had some claims to learning. Arkwright was induced to abandon his chimera, and he then turned his attention to the improvement of the machinery for the spinning of cotton. At this period, cotton was scarcely known in Great Britain as an article of commerce, whilst at the present day, it is in a commercial and manufacturing point of view, the most important; employing a large portion of her population in the various processes connected with it, and increasing the national wealth in an unexampled degree.

An individual, obscure, and apparently powerless, was destined, by his mechanical skill, to produce this mighty revolution; the business which he created, caused towns to be founded, where, otherwise, hamlets could scarcely have existed; and has given to the cultivator of the soil in our own (the United States), and many other countries, a most important article of produce, exhausting it but little, remunerating the labourer for his toil, and furnishing to every civilized country, innumerable articles of comfort and convenience. Before dismissing this eminent individual, we will remark, that the essential improvements made by him, remain with little or no alteration to the present day; these are, the ingenious mode of drawing out the cotton by means of rollers, and the beautiful process of delivering it from the cards in a continued fleece. The mechanical genius of Arkwright was not his only excellence, for after having carried his inventions into complete effect, he introduced into the manufactories in which he was concerned, a degree of order, cleanliness, and industry, altogether unexampled in any similar establishment. After speaking of the improvements made by Arkwright, in the manufacturing

of cotton, we are led, by a natural association, to the steam-engine, as it came out of the hands of that scientific mechanic, Watt. At the time when Arkwright was bringing his machinery to perfection, Watt was a mathematical instrument-maker, in Glasgow. Having attended the lectures of Dr. Black, who was then professor of chemistry in that place, he had become acquainted with the doctrine of latent heat, as discovered and taught by that eminent individual. A working model of the atmospheric steam-engine was placed for repair in the hands of Watt; and he was led to remark the great waste of heat, in the condensation of the steam; a waste, the amount of which could be estimated only by one possessed of the scientific knowledge which he had derived from Dr. Black. To obviate this, required that singular skill which he displayed in the improvements which he introduced; producing economy in fuel, acquiring a vast accession of power, and rendering the motions of the machine so equable and manageable, as to adapt it perfectly to the purposes of the manufacturer; thus giving him a first mover, which he could use wherever a small quantity of water, and the requisite fuel, could be obtained. The steam-engine, therefore, contributed in an eminent degree to the success of the cotton manufacture, as well as to that of many others.

We shall have occasion to exhibit to you, at some other time, various proofs of the eminent skill of this philosophical mechanic, who, whilst he acquired the wealth which he so well deserved, gave to his country, and to the world, an instrument more powerful in its operation, and more general in its application, than any previously known. At the Chacewater mine, in Cornwall, there is a steam-engine erected, of 1010 horse power, and, of course, performing the labour which would require the employment of 3030 horses, supposing a horse to perform 8 hours constant labour, in every twenty-four. By this engine, a mine of 600 fathoms deep is kept dry. In numerous instances, mines which had been abandoned, in consequence of the

impossibility, or the expence, of keeping them from water, are now worked with facility and profit; and the engine is applied to a variety of purposes, too numerous to detail. In the structure of the steam-engine, in its present improved state, we see the application of the principles of mechanical philosophy, in a number of beautiful and ingenious contrivances, which give to its motions the appearance of intellectual impulse; whilst a knowledge of the most recondite principles of chemical philosophy is displayed in the formation and arrangement of its several parts; exemplifying in a manner the most striking, that "knowledge is power," and proving the correctness of the observation, that this machine is "a present from philosophy to the arts."

(To be continued.)

V.—*On Mr.* Ross Winans's *Improved American Carriage for Rail Ways, and on Rail Ways. By* J. L. Sullivan, *Esq. Civil Engineer* *.

The public works of our country have received their impulse, and public opinion is daily attaching to them an increased value. The form first given to them had a direct relation to the more immediate and most important object, the domestic trade of the States to which they belong. But there is also another valuable object, not always sufficiently distinguished, namely, profit from transport. The agriculture of our extensive vallies, and the minerals abounding in their mountainous borders, demanded canals; and favourable ground, with abundance of water, recommended them. But revenue from transit commerce originating beyond the borders of the State, most active when the western waters are favourable to conveyance far into the country, the elevation of the intervening ground, and our climate, seem to prescribe rail-road communications.

* From the "Journal of the Franklin Institute." This carriage is patented in this country.

The reasons which induced the intelligent citizens of Baltimore not to rest contented with the Potomac and Ohio canal, but to undertake a rail-road of unexampled extent and boldness of design, in order that merchandise from that city might reach the Ohio seasonably, are obvious; and if general considerations were sufficient to justify that resolution before the new carriage was known, how much more confidence may now be entertained, since, by this invention, the Alleghany mountains will be traversed with as much useful effect as the plains of England have hitherto been; and steam power add unexampled expedition to unprecedented economy.

While, therefore, the products of Virginia and Maryland from along the tributaries of the Potomac, must give ample occupation to that canal, as those of New York do to Erie, and as Pennsylvania must to those formed by this state, it will be found that more must be done; that the system of communication will be incomplete until Philadelphia draws her supplies of merchandise from New York, by the facility of a rail-road; and the interior of the States shall reach the wheat market in winter, by a continued rail-road, the whole distance from Carlisle. It is alone by economy of access to market, that the flour of Philadelphia can be afforded as low as will be that of Baltimore. And New Jersey will make her canal, but will not neglect a valuable source of revenue more sure, from a rail-road for winter travel.

The opinion appears to be established, that our country requires a different kind of rail-road from that employed in England. The comparative density of her population, the immensity of her trade, and the moderate extent of her territory, are all contrasted with our widely extended States, and spare population; but while the greatness of our agricultural produce supplies the deficiency in the comparison as to quantity, there remains with us the present disadvantage of great distances, the uncommon length of our public works of this kind. Less expensive modes of construction,

in order that the investments may not be a loss of value in the first hands, seems indispensable.

Various forms of rail-ways have been suggested, and some of them sacrifice durability too much to cheapness. I aim, therefore, to show, how there may be saving enough in capital to allow, besides ample dividends, a reservation from revenue, to form a renovating fund. If this fund is allowed to accumulate at compound interest, rail-roads of a kind suitable to our climate, may be among the best property, because they are not liable to be rivalled, like turnpike-roads, by free roads. Rail-ways cost too much ever to be free; besides, they must have appropriate carriages, owned by the proprietors of the roads, in order that the public may have full accommodation. The public has the same interest with the owners, in there being an ample number of waggons.

Perhaps it will be found that a rail-way of the following description will combine economy with long duration. It will not indeed be elegant, but substantial.

No rail-road can be of long service that is not substantially and accurately made. We may use cheap materials, but the foundations and workmanship must be perfect. In England, they employ much broken stone, for reasons not so applicable to our plan as to theirs. It serves to keep their stone blocks in place, and to fill the trenches in which they rest. But great care is to be taken to form underdrains, and they also take other precautions to keep the earth dry, and consequently hard. We should have occasion to go to more expense for the same object, if it were accomplished effectually. They have only to guard against the effects of one foot of frost in depth, but here it penetrates two or three feet. Ice must not be suffered to form among the foundation, and it must therefore be kept dry. But when our plans and estimates propose an imitation of the English rail-way, how is it that the cost is made to appear less, notwithstanding that the iron and labour here cost double the expense? It is because the ground-work

is not deemed necessary to be so guarded with precautions. Again in this there is danger of saving too much.

Timber is so plentiful in some parts of our country, that nothing seems easier than to have a rail-road, by laying down cross-sleepers, surmounting them with string pieces, and these latter with iron. But how long will it be before the decay of the surface in contact with the ground will disturb its level and parallel, and the travel upon it tear it to pieces? Posts set in the earth, will be more substantial, and they may be guarded at the surface in the following manner.

It is well known that all posts rot only at, and a little below, the surface of the ground, where heat and moisture combine. Now it has occurred to me, that these two causes of decay may be counteracted, by surrounding those parts of the posts by pavements set in lime, or Roman cement.

Another mode proposed to save expense, is recommended for the Boston and Providence route. It is that of long stones set edgeways on broken stone, to receive a plate-rail. But besides the difficulty of fastening iron to stone, this plan places the rails too near the surface, and subjects them to be covered with ice. The foundation must also be rammed equally solid throughout, or otherwise the passing of four ton loads will depress the string-stone where least supported. It has, besides, more liabilities to derangements than posts, and cannot cause much saving, if the requisite drainage is properly done.

Perhaps the cheapest plan, consistent with firmness, is the following. Let the object be to make as much of the road permanent as can be done at an ordinary expense. Let embankments be made solid at once, by puddling them. Where wood is used for posts or piles, let them be protected with the cemented pavement, be set in puddle filled with stones, and their heads be also protected; or, instead of broken stone and stone blocks, set rough stone posts, three feet in width, and one foot out of the ground;

their heads being hewn smooth, and also drilled, to receive a treenail in each, with which to secure the bearing timbers together and firmly down at once.

If the bearing timbers are of chesnut, they will be very durable, if split or sawed from the heart of the tree to its circumference; because quarters or eighths of the tree, thus prepared, will shrink equally, and not crack. Being also lodged upon the heads of stone posts, they will not decay at the parts in contact; the horizontal scarps should have their surfaces separated by the intermediation of a cement formed of lime and pitch, a composition used by shipwrights.

The form of the timber allows the heart angle to be placed uppermost, and to be taken off, and a surface formed thereon of three inches in width, for the reception of the rail. A tree of two feet in diameter, will afford eight pieces, of nine inches in depth, and with a base of nine inches; and these dimensions, if the posts are even ten feet apart, will be sufficient to bear loads of four tons, and also be of sufficient lateral stiffness.

The upper surface of the bearer is liable to be heated by the iron while exposed to the sun, and to shrink and crack. To prevent this, the plate may be put on with screw-bolts, reaching through, with washers and screw-nuts below; but to give the rail a firm bearing, and allow the cement of lime and pitch placed under the plate to remain, two rows of inch nails, and an inch apart every way, may be driven evenly with the surface of the wood; and then, if the upper surface of the plate is convex, the wheels will run along the middle, and the pressure be equal. The passing load will not have a tendency to loosen this rail, as if it was made flat, for a flat rail cannot be mathematically a true plane.

The modes of crossing roads, rivers, &c., are not essentially changed by this plan.

The carriage requires a rather minute description to be understood by those to whom it is now for the first time presented.

If a rail-way is formed firm, smooth, and level, the resistance to be overcome is only friction at the axles, and gravitation, when the load is ascending. The latter being a uniform force, when resisting the ascent of carriages and their load, its ratio, according to the height of the plane, is alike applicable to the old and the new waggon. Friction must ever exist, however lessened by the polish of surfaces, and the use of oil, in proportion to the weight pressing them together. The experiments of Vince proved it to be a uniformly retarding force; those of Colomb, that velocity, increasing in geometrical progression, only increased it in arithmetical progression. And we have, you well know, the experiments of Emerson to prove the proportion of power to weight, when metals of different kinds move on each other. It seems agreed, that iron and brass require one-fifth.

But when the surfaces in question are those of an axle, and the nave of its wheel, the friction is placed under circumstances to be overcome by the augmented power of the lever, that of the second class, which, of course, common wheels are well known to be.

The mechanical ingenuity of England, appears to have been directed to the perfection of the rail-road and engines; the carriage had received no farther improvement than good workmanship. This had achieved the important advantage of reducing the power, according to general practice, to the one hundred and seventy-fifth part of the load.

In this stage of the art, Mr. Winans conceived the idea of combining in one carriage, the first as well as the second classes of the lever. The effect of friction rollers, and friction wheels in machinery, were, no doubt, as familiar to his, as to other minds; but to make a convenient carriage by this combination, principally for rail-roads, then only beginning to be thought of in our country, was worthy of any mind familiar with mechanical science, and practised in ingenuity. It was not, until some time had elapsed, that, in 1826, he presented his first model at the Patent Office,

with the inquiry, whether this combination in a carriage was known there. Learning that it was not, he deposited it in evidence of his right, and subsequently made that form of a compound carriage which is described as follows:

The wheels of common carriages operate as levers of the second class, because the wheel turns on the axle; but when the axle turns with the wheels, it operates as levers of the first class, or as a windlass.

The main travelling wheels of his carriage, are of the latter kind. The fixed axles pass through the wheels, and extend about nine inches from them, on each side; the last three inches thereof being converted into smooth gudgeons or pivots. These enter the upper parts of the rims of the secondary wheels (those of the second class of the lever), which, in this modification, are placed outside the large wheels, but do not touch the ground, and are of about half the diameter of the large wheels. They have each short axles, which work in brasses, placed underneath the side pieces of the frame of the carriage, and between which, they are lodged. Their rims hanging on the gudgeons, their short axles bear up the load-frame; and when the primary wheels roll forward on the rail-road, their axles turn, and the gudgeons roll in, on, and under the smooth surfaces of the rims of these outside wheels, which, of course, revolve slowly; and turn perhaps once, while the large wheels and axles revolve ten times; the bearing or rubbing axles moving thus very slowly, perhaps no attainable speed of the carriage would cause them to heat.

This form of the carriage thus requires no fixtures; but in essential parts are combined naturally together, and work without any liability to separate. Nor is there any friction but that of the small axles, which it is the object of the leverage to overcome. The friction, nevertheless, must be still there, however slow they move. Comparative slowness is incident to leverage. The space described by the surfaces, may be a good index of the power employed in this

case; but the experiments of Walker and others, have shown that the ratio of resistance is as the weight, nearly; and not as the velocity. Indeed, it is evident that the motion of the one end, and of the other, of a lever, is relative. The gain of power is neither augmented nor diminished, by the quickness of the application.

Thus the compound leverage of this carriage conquers the resistance of friction, and allows the augmenting the quantity of the load. The horse draws the instrument of his power, as a part of his labour. His speed, like that of the steam engine, would accelerate, till the force and the resistance balanced each other, or steadiness was attained.

(To be continued.)

VI.—*On a New and Improved Plan of Constructing Iron Rail-ways and Carriages. By the Chevalier* BAADER, *of Munich**.

Munich, March 19th. 1828.

It is generally acknowledged by the most eminent engineers, and by the most impartial writers on mechanical subjects, that the present construction of rail-ways, and of the carriages or waggons conveyed upon them, is still very far from being arrived at that degree of perfection of which, by their principles, they appear to be susceptible; and it cannot be denied, that, upon the whole, this most invaluable invention is yet in a state of infancy.

To this imperfect state it is undoubtedly owing that these artificial roads, though known, and partially used, for a century past, have not till now been extended over whole countries, and used for all sorts of conveyance; and that the greater part of those companies which, a few years ago, had associated themselves for the establishment of rail-ways, in different directions, all over England, have been dissolved; and almost none of those numerous and

* From the "Journal of the Franklin Institute."

magnificent projects, which were announced in the English papers, have been carried into execution.

It is, therefore, my opinion, that before any important and extensive plan of this kind can be adopted with a certain prospect of success, it will be necessary to bring these roads, with their vehicles, and all their other mechanical contrivances, to a higher degree of perfection, by removing all the difficulties and inconveniences to which, in their present state, they are subject.

In the first place, on the flat rails, or tram-ways, as well as the edge rails, the continual rubbing of the wheels against the upright rims of the plates, or of the projecting flanches of the wheels against the sides of the rails, cause a considerable resistance, by which not only a great part of the moving power is wasted in an useless manner, but they also tend to loosen the rails, and to disturb their foundations. These effects are particularly visible on all those sorts of rail-ways where the carriages are drawn by horses, who, by their trampling, shake the sleepers, and the whole foundations, in such a manner, that the rails become loose in a short time, and their joints are displaced; their ends stand up, and their parallelism is destroyed; the immediate consequences of which are an increased resistance, violent jolts, frequent breaking of the wheels and rails, continued repairs and delays, and the speedy destruction of the whole.

In the second place, where horses are employed, the flat as well as the edge rails, but particularly the first kind, are continually filled and covered with sand, gravel, or mud, thrown up by the feet of the horses, so that the rails often become so obstructed as to occasion a considerable resistance to the carriages passing on them.

Thirdly, with regard to the waggons or carriages used upon either of these rail-ways, their present construction is so clumsy and defective in every respect, that they hardly deserve the name of machines. As both axletrees are immoveably fixed to the body of the waggon or tram, so these vehicles can only move forwards and backwards in a

straight line, and the least deviation from the straight line occasions a very considerable rubbing and friction of the wheels upon the bottom, and against the sides or rims of the rails; and, of course, produces a great additional resistance, together with a most destructive wear and tear of the wheels and rails.

Fourthly, on such places where a rail-way ceases, or where it must be interrupted, which is unavoidable upon long lines, passing through towns, over long and narrow bridges, &c., these waggons are incapable of leaving the rails and being brought over any common roads, paved streets, or other ground. They must, therefore, be unloaded, and their contents be carried forwards upon common carriages; a very troublesome operation, and which is always attended with expense, and great loss of time.

Fifthly, one of the greatest objections to the present system of rail-ways is, that the carriages are so confined to the tract of the rails, that they cannot, like common carriages upon a turnpike-road, turn out, to pass each other, when meeting upon the same line, or where a slow moving train is overtaken by a quicker one. The siding-places, or turn-outs, employed for that purpose in England, are but very imperfect contrivances. They can only be placed at certain distances, and are of no use to the carriages meeting between those places. Their management is also extremely tedious and troublesome; and though for want of a better and more convenient method, they may answer for the slowest transports; yet they will be of no service at all for quick conveyances, on account of the great loss of time attending every such operation, and of the danger of the carriages running foul of each other; because the *momentum inertiæ* of such masses, cannot be stopped so quickly and easily upon a rail-way, as upon a common turnpike-road.

Sixthly, as the principal advantages of rail-ways, and their great superiority over canals, consist in the quickness of conveyance, and in the possibility of employing mecha-

nical power, instead of horses; so the loco-motive, and stationary steam-engines, have been proposed, and partly introduced in England, for the propelling of all sorts of vehicles upon rail-ways. But of all the trials which, till lately, have been made, not one has yet succeeded to such a degree as to fully answer the sanguine expectations of their projectors. The greatest speed which, with either of these engines, could be given to a train of heavy loaded carriages, without the most imminent danger of dashing both carriages and rails to pieces, hardly exceeded six miles per hour; and as the greatest part of the power possessed by the loco-motive steam-engines is absorbed by their own weight; and that of the stationary steam-engines is lost from the weight and friction of the long ropes and chains employed in drawing the carriages, so the expense of fuel is very considerable, and even surpasses the expense of horses, wherever a ton of coals costs more than eight shillings.

Being perfectly acquainted with all the newest mechanical inventions in England, and strongly impressed with the high importance of this particular subject, so I have, for these twenty years past, applied myself with the greatest assiduity to the improvement of rail-ways and carriages; and, by a constant study, and after many expensive experiments, I have at last succeeded in contriving an entirely new plan, by which all the difficulties and inconveniences above enumerated are completely removed; and the conveyance upon rail-ways is now brought by me to a degree of perfection which was scarcely thought possible.

The principal advantages of this new plan are the following:

The rails are constructed in such a manner, that the carriages move along them with the greatest facility, and without any sensible lateral friction, though the wheels are constantly kept upon their tracks. By this means, and by a more advantageous, and yet simple, construction of the waggons, the resistance is so much reduced, that, upon

dead level, the power of one horse is sufficient to draw with ease, and at a good pace, a load of from twelve to fourteen tons, when divided amongst several carriages linked together.

The foundations of the rails are fixed in a much more solid manner than usual; and, as the horses do not draw between the rails, but on the outsides of them, and upon separate paths, so their trampling cannot injure the foundations of them, nor can they throw, as usual, any sand or mire upon the rails, which, of course, will never be obstructed thereby.

The peculiar construction of the carriages allows them not only to turn without the least difficulty in any deviating direction, and upon a curved rail-way of the shortest radius used, for instance, of twenty feet; but also to leave the rails, and be conveyed over common roads, like any ordinary waggon. These carriages can go on therefore without any interruption, through towns and villages, and over bridges, where the rails cannot be continued; and they also remaining loaded, till they arrive at their final destination.

By a very simple and easy contrivance, my carriages can also be turned from off the rails at any point where it may be found necessary, as either to avoid other waggons meeting on the same track, or to pass by those which they have overtaken, and return again into their first line; so that no siding places, turning plates, nor any other apparatus of these kinds, are necessary for such an operation; and which can be performed almost as quickly and easily as upon a common turnpike-road.

This very important improvement affords the advantage that a double track of rails will be sufficient for the most frequented traffic or intercourse; and for which, in the common way, five or six parallel tracks would have been requisite; and also, that any number of slow moving and heavy waggons can pass on the same line, and at the same time, with as many light and quickly moving carriages, and whether moving in the same or in opposite directions.

To employ the power of steam or other first moving powers, with the greatest advantage, and with the least possible expense, in the propelling of all sorts of carriages upon rail-ways; I have discovered a new principle, by which the power and motion of stationary steam-engines, and other machines, established at considerable distances apart, along the rail-roads, and working without interruption, can be imparted to any number of loaded carriages passing upon the rail-way, from one steam-engine or machine to another, without the employment of drag-ropes or chains, or indeed of any intermediate apparatus, and yet with any reasonable degree of velocity!

A rail-road and carriages, constructed upon this new plan, and with all these improvements and new inventions (the reality of which is partly proved by experiments made upon a tolerably large scale, and is partly founded upon the most infallible principles, and for the success of which I will make myself responsible), cannot fail to have a decided superiority over canals, as well as over rail-ways of the present construction commonly used in Great Britain.

This superiority has already been acknowledged by a committee of the Royal Academy of Sciences, and by committees of the Agricultural and Polytechnical Societies at Munich; and who, after having examined my plan, and assisted at the experiments, have made and published very favourable reports thereon. And although there is in this country a party strongly interested in canals, yet all our proprietors and capitalists, and also the majorities of both houses of our representative assemblies, are so well instructed and disposed, that my plan for uniting the two greatest navigable rivers in Germany, the Danube and the Rhine (through the Mayn), by means of an iron rail-way of my invention, is about to be adopted.

But I am convinced, that no where in the world, the introduction of this new plan of rail-ways would afford such immense advantages as in the United States, where the most rapid and prodigious progress in every branch of in-

ternal improvement, industry, and commerce, protected by the wisdom of an enlightened and liberal government, and supported by the public spirit of an enterprising nation, are already the admiration of all Europe; and where, to arrive at the highest degree of national wealth and prosperity, nothing more is wanting, and nothing can be more desirable, than the greatest possible multiplication and facilitation of internal communication.

By adopting this plan, instead of the ordinary English system, the iron rail-way between the Baltimore and the Ohio, the construction of which is already decided upon, might be established with much greater advantage, and with a saving of nearly two millions of dollars.

It has lately been proposed to unite the Chesapeake bay with the Ohio, by a canal between Georgetown and Pittsburgh; and the expense of this canal is previously estimated at 22,575,426 dollars, of which sum nearly one-half will be required for the middle section alone, on account of the great number of locks, and a most expensive tunnel, by which this part of the canal is to be conducted over the highest point of the Backbone mountain. As far as I am able to judge, from the report transmitted by a message from the President of the United States, and published at Washington last year, it appears to me that a double track of iron rail-ways, with a sufficient number of stationary steam-engines, executed in the most complete and solid manner, would answer the purpose infinitely better, and save about two-thirds of the above sum, and as much of the time required for the conveyance of all articles, from one point to the other. Light vehicles, with passengers and mails, might be transported upon this rail-way with the greatest safety and convenience in thirty-six hours, by day and night. Besides there would also be the very important advantage, that the rail-way might be used during the whole year, with very few interruptions; whereas, the navigation upon canals, in that climate, is generally confined to eight months only. If, however, my plan could

be adopted for the middle section only, and upon a length of seventy-two miles, a saving of from seven to eight millions of dollars might be easily made, and the traffic be carried on with greater expedition. But as, in this case, the loading and unloading from the vessels in the canal, to the carriages upon the rail-way, and vice-versa, would be rather troublesome, and attended with extraordinary delays and expenses; so I should recommend the construction of a rail-way for the whole line between Georgetown and Pittsburg, by which about fifteen millions of dollars would be saved, the whole work be finished in a shorter time, the expense of maintaining in repair be greatly diminished, the transport rendered more expeditious and convenient, and the annual income to the share holders and proprietors might be doubled, even with a lowering of the tolls.

The Chevalier JOSEPH DE BAADER,

Knight of the Order of Merit of the Bavarian Crown; Counsellor of Mines; and Professor of Practical Mechanics, at the University of Munich; Member of the Royal Bavarian Academy of Sciences, and of the several Learned Societies; and one of the Directors of the Board of Agriculture, and of the Polytechnical Society at Munich.

VII.—*On viewing the Circulation of the Sap in the Chara Translucens.*

THE Editor has at length been gratified with a view of this interesting sight, and, indeed, in an unexpected manner.

Mr. Gray, of the British Museum, favoured him with a fresh specimen of the *chara translucens* about a month since, but which, being of a deep green colour, it rendered it impossible to see any thing passing in its interior. However, upon the Editor placing a joint of it, surrounded with water, and prepared in the manner described in our last volume, page 263, under his Varley's microscope, with a lens of the tenth of an inch focus; he found, that after remaining in water for several weeks, it had become nearly transparent, and he saw, for the first time, the sap flowing within it. On this, he changed the lens for one of the

twentieth of an inch focus, and then had the pleasure of seeing it still more distinctly, flowing in two opposite directions, and exactly as described to him by Mr. William Tulley.

He afterwards prepared others, by scraping off the thin outward skin with a sharp knife, and thus rendered them transparent, in a manner indicated to him by Mr. Gray (and who, as well as other gentlemen in the British Museum, had witnessed the circulation of the sap in parts of the chara thus prepared six years since), and then found he could discern the flow of the sap as before, in the parts thus rendered transparent.

It is a curious fact, that a plant should thus retain the power of circulating its sap under water, for nearly a month after it had been removed from the place of its growth; and still more, that short portions of it, separated from the rest of the plant, should likewise possess a similar power; and this at a time of the year when vegetation is nearly at a stand. In short, this is the most interesting appearance which the microscope has ever afforded him.

Great care should be taken in scraping off the external bark, not to injure the sap-vessels, which have a delicately ribbed or granulated appearance; and the light of a candle or lamp is necessary to exhibit the minute globules of sap, slowly meandering along the ribbed channels in the vessels; sometimes, however, the globules of sap are larger than ordinary, and are, of course, more readily seen; but it requires an excellent microscope to view them distinctly, and a nice adjustment of the lens, as well as a proper management of the light; and, indeed, when Professor Amici, of Modena, first announced his discovery of this interesting fact, namely, the circulation of the sap in a plant rendered visible; it was considered as being owing to the very superior excellence of his reflecting microscope. The Editor, however, now finds, that his Varley's single microscope is fully capable of exhibiting this beautiful appearance.

It is not necessary that the watch-glass, in which the

prepared piece of the chara is placed, be filled with water, as before mentioned in our first notice of it, but it is sufficient merely to apply a little water along the sides of it, which renders the view of it much more facile; and the circulation of the sap will nevertheless continue for a considerable length of time.

This beautiful appearance did not present itself to the Editor's notice in time to form a part of the microscopic article in the present number.

VIII.—*On Diseased Cattle and Bad Meat.* *By* Mr. CHARLES WHITLAW.

(*Continued from Vol. V., page* 302.)

Patent Medicated Vapour Bath Establishment,
No. 14, *Finsbury Place South, London, December* 9, 1829.

DEAR SIR,

I MENTIONED in my former letter, that Mr. Davis, a butcher at Bayswater, had afforded me an opportunity of putting my remedies to the test of experiment. For this purpose, I mixed three ounces of common salt in a pint of water, and gave half a pint of it each to two sheep, on the Thursday, and the two successive days; on the following Tuesday, one of the sheep was killed; and, on examination, only three flooks were found in that part of the liver called the *vena porta*; one of these was quite dead, and of a white colour; and the remaining two were very sickly, and apparently dying. The other sheep was killed next day, and, on examining its liver, we found eight flooks in it, four of which were dead, and the rest of a green colour, indicating approaching death; and on tracing the gall-duct, from its junction with the liver, to its opening into the intestine, we found numerous pieces of flooks in a decomposed state. The following day, four sheep were killed, two of which had been drenched with lime-water and the juice of the *arbor vitæ*; but in these no living flooks were found, although we found a considerable number in a partly

decomposed state. Two other sheep had been drenched with common salt and the juice of the *arbor vitæ*, but in this instance we had experienced great difficulty in throwing the injection into their stomachs, in consequence of the neck of the syringe being too short, and which had occasioned the liquid to pass into their wind-pipes. On killing these sheep, we found the *vena porta* in each full of flooks; some of them were just alive, whilst others were in a state of dissolution.

Several gentlemen were present at the opening of the sheep, and were highly satisfied at the results of these experiments, being convinced that the flook might be entirely destroyed by these simple yet efficacious means.

On examining the mesentery of one of the sheep, I was particularly struck with its unnatural appearance; and, on farther investigation, found the glands of it enlarged, obstructed, and affected with scrofula. On opening several of the glands, we found them filled with matter; and in others, it was oozing through small ulcerated orifices, into the cavity of the abdomen. The lungs were also diseased to a great extent, being studded with tubercles, and parts of them in a state of decomposition; presenting, as nearly as possible, a similar appearance to those of the human species, who have died of scrofula and consumption. The livers were diseased throughout with a kind of earthy deposition, evidently cellular, and of a bony structure, and which might truly be called bony tumours. We also found a number of *hydatids* hanging from the mesenteric glands, and around the region of the liver.

Finding Mr. Davis to be an intelligent man, and one who had paid considerable attention to the diseases of sheep, I made particular inquiries of him as to the probable number of them which were affected with scrofula; and was surprised to learn, that one-fifth, at least, of all the sheep bred in the pastures of England, were diseased either in the glands or lungs, and that the evil was rapidly increasing!

Mr. Davis informed some of the more intelligent butchers of my success in destroying the flook in sheep; but all of them were sceptical, believing that every means had hitherto failed in effect. I myself also called on a number of butchers, requesting them to come and see the sheep killed; but not one of them attended. One of the first butchers in London, and who is also a cattle salesman, had indeed requested me to repeat my experiments, and was expected to attend when the sheep were killed; but, for some reason or other, he did not come. And, as the experiment was an interesting one, and deserving of attention, so I trust your liberality and zeal for the general good, will induce you to give it publicity.

The six sheep selected for this last occasion, were diseased beyond what could have been imagined, indeed, so much so, that one of them was obliged to be killed after the first drenching; and, on examining its liver, in order to ascertain the extent of the disease, upwards of half a pint in measure of flooks were found in the vena porta and the gall ducts. Indeed, the other five sheep were all equally bad. After drenching three of them with salt, and the juice of the *juniperus sabina* (savin), and two of them with lime-water, for five successive days, two were killed; in the one drenched with salt, we found upwards of forty dead flooks, some in a state of decomposition; and about forty others in a very sickly state, and crowded so closely together, in the *vena porta*, as almost to close up that important vein. The other sheep had been drenched with lime-water, and upwards of one hundred flooks were found in it, more than one half of which were dead, and the remainder in a very sickly state. The three remaining sheep were drenched three times more, and when killed, the two that had been drenched with the salt mixture had not more than two dozen of living flooks in each of them, and an equal number of dead ones, of a white colour. On examining the first portion of the small intestines, called the *duodenum*, a great number, however, were found in a de-

composed state. The last sheep that had been drenched with lime-water, had a dozen of living flooks in the *vena porta*, which just showed signs of life, and more than twice that number of dead ones; but on opening the gall-duct and intestines, a considerable number were found, partly dissolved. A fairer experiment, or a more convincing one, could not have been made; for, had we found no flooks at all, the sceptical would have said that there had been none in the sheep.

I have lately travelled to Hastings, and paid particular attention to the appearance of the country. The land, generally, is of a stiff clayey nature, and has a cold subsoil, even to the tops of the hills; much of it requires draining, and a large portion seems totally useless, not so much indeed from the nature of the soil, as for want of cultivation; it yielding only bushes, heath, and furze, with many poisonous weeds, the seeds of which are blown over extensive tracts of land, thus sowing our fields with plants obnoxious to cattle.

There are indeed a few farms in an excellent condition, and which form an honourable exception to the slovenly manner in which most of the farmers keep their land. In those farms where a more rational agricultural policy has been followed, and improved implements of husbandry introduced, the savings of expense and labour are immense! I observed on one farm, a clumsy heavy plough, dragged along with the greatest difficulty, by four oxen, and two horses, with two men to manage them; such a scene, in the nineteenth century, is truly ridiculous! In this farm, the pasture-fields were top-dressed, and covered with poisonous weeds; and notwithstanding the land was hilly, yet the sheep were diseased with the flook in great numbers. I observed them ploughing on another farm, equally stiff and clayey, with only two horses and one man; and yet proceeding with greater ease, and making better work, than those in the first farm; besides a saving of at least two-thirds of the expense, as a horse will consume more

grain than is sufficient for the maintenance of six people; and instead of the farm being overrun with obnoxious weeds, it was covered with the finest clover, and the best selected artificial grasses. I examined the sheep and cattle, and believe that there was scarcely a diseased one among them. Such a farmer is truly a benefactor to his country. I inquired the reason why the adjoining farmer did not adopt the same agricultural policy? and was answered, that the want of money to purchase implements was the principal cause, as the church and poor rates, with the expense of cultivating the soil, absorbed nearly the whole produce of the land, and left little or nothing to pay the rent.

In conversing with some of the most respectable butchers in Hastings, they told me, that, with the exception of the sheep that were brought from the few well cultivated farms, and the Downs, there was hardly a sound sheep in the country. That many of the farmers had lost their whole stock, and nothing but ruin was staring them in the face. A few months will bring our agriculturists into the most deplorable condition. I made a visit to a gentleman who has an extensive farm in the vicinity of Hastings. I was much pleased to see the great improvements he was carrying on, yet the heavy poor and church rates left him nothing for himself! It is a most painful reflection to an individual, that after laying out thirty thousand pounds for the purchase of a farm, and expending large sums on it, during a period of six years, and by which its produce is doubled, yet that the above grievous exactions more than keep pace with all his improvements! His sheep and cattle were in the finest condition; and the lime compost which he had laid on the soil was covering his farm with clover and fine herbage. I tasted some of his butter, a week old, and candidly confess it was the best I ever tasted in England. The only consolation or encouragement I had to offer him was, that his posterity would reap the benefit of his exertions.

I will give one example more, of a relation of mine, who purchased a farm for twenty thousand pounds, seven years ago, and has since laid out twelve thousand more for improvements. He has never yet received any remuneration, as the servants' wages, parish-rates, and taxes, amount to more than the annual produce of the farm. At my suggestion, his steward has been giving salt to his sheep and cattle frequently during the summer. He had several of the sheep killed, suspected to be diseased, but no flooks were found in them, and the meat was perfectly healthy. He informed me that he had had but few deaths among his stock; whilst his neighbours had lost, in many instances, more than three-fourths of their flocks; in consequence of which, many respectable farmers have been reduced to want and misery. It is earnestly to be hoped, that Government will now interfere, and devise some means of relief. All are agreed that something must be done; and the plan that I should propose would not only relieve the farmers, but ensure an abundant supply of sound meat, and wholesome provisions of every description; besides advantageously employing every pauper in England. Every person in England ought to be employed, and fully remunerated for his labour, which should be fairly regulated by the prices of provisions. No proprietor, or land-holder, should be subjected to support any one (the aged and infirm excepted) when he is willing to employ them, and give them a fair compensation for their labour; and as a great portion of the land in England is overrun with poisonous weeds, rendered still more destructive by growing on wet land, so I would propose that land of this description should be subjected to draining, and under-draining; as by the moisture, cropping, and top-dressing, it is rendered sour; and thus produces many obnoxious plants, and harbours myriads of insects. The sheep and cattle, when turned into pastures of this kind, become diseased with scrofula, hydatids, and consumption; and the people eating the diseased butcher's meat produced from them, must, in

their turn, become the victims of similar complaints. To suppose that a person could partake of such meat, and that no injurious effects should result from it, is contrary to the laws of nature and common sense! An extensive cattle salesman indeed assured me, that the poor were not diseased by feeding on such meat, as he had frequently sold it to them, and had never observed any bad consequences arising from it. Unfortunately, this individual has ready access to the constituted authorities of the city, and his opinion is likely to have great weight with them. It is to be lamented, that the view he has been led to take of the subject is so much at variance with the health of its suffering inhabitants.

I do not allow my patients to eat diseased butcher's meat, nor indeed the fat of any meat; as the oils of poisonous vegetables are taken into the circulation, and deposited in the cellular membranes, and other parts of the bodies, of the animals feeding upon them. When such meat is eaten, it is sure to produce bilious attacks and indigestion, and especially in weak stomachs. Hence, the thousands of volumes published, attempting to give a reason for their prevalence, without any two agreeing as to their true natures. The Greeks first discovered the scrofula to be produced from the use of pork, swine being animals particularly subject to that disease. A physician of eminence, and who has been a member of the Royal College for many years, assured me he had never heard from any of his medical brethren, nor read in any work, that sheep were also diseased with scrofula. He was therefore greatly surprised when I mentioned the fact to him, and agreed with me, that people eating the flesh of any animal, to any extent, that had been affected with scrofula or consumption, would certainly contract diseases. Let any one examine the various opinions and theories which have been from time to time advanced on the subject, and he will at once perceive the reasonableness of all that I have stated, and the just conclusions which

may be drawn from the facts, which I have proved to demonstration.

I have made a number of inquiries of other butchers, and they informed me that the statement given on the authority of Mr. Davis, was not exaggerated; as they likewise told me, that one-fifth of the sheep were diseased with scrofula and consumption, independent of those afflicted with the flook.

I feel myself greatly obliged to Mr. Davis for the expence he has put himself to, and the zeal he has manifested, in procuring us a number of sheep to experiment upon; and likewise endeavouring to further our object, by affording us all the information in his power.

It has been asserted by our first medical men, that scrofula and consumption are incurable diseases, yet I find no difficulty in curing both; and even cancer, in its incipient stage. But I do believe, that I could not have cured a single case, had I permitted my patients to eat such meat as is too generally found in the markets.

For the purpose of clearing our fields, and of ensuring an abundant supply of wholesome food, I would divide the paupers of each parish amongst the land-holders, which would lighten the burden of the poor-rates; and by their labour, the land might be brought into a state in which it would yield double to what it now produces.

In conclusion, the most grateful return I can make to the British public for the patronage and kindness I have received, is to use my utmost endeavours to remove the causes of their sufferings.

I remain, dear sir,

Your's, &c.

To T. GILL, *Esq.* CHARLES WHITLAW.

IX.—*On Crude or Unburnt Bricks, and on Factitious Stone. By* M. Hassanfratz.

It is a fact well known, that crude or unburnt bricks were extensively used by the ancients, as they are found in the ruins of various towns and edifices, which were erected at a very remote period of time; among these may be particularly mentioned the ruins of Babylon, from which, at a recent period, have been obtained both burnt and unburnt bricks, in a state of preservation so perfect, as to exhibit the inscriptions impressed upon them at the time of their formation.

In Europe, the use of burnt bricks of small dimensions has been continued; but crude bricks are rarely employed, scarcely ever indeed, excepting in the construction of ovens, furnaces, or fire-places, where they will receive a degree of baking, which will render them durable. Crude bricks are still extensively used in some countries of Asia, and it may be worth while to inquire, why the practice is not more general, particularly in places where stone and fuel are scarce?

Two opinions upon this subject, altogether irreconcilable, have each their advocates. Crude bricks, it has been declared, have but little solidity, and soon moulder; it has been on the other hand averred, that they are so durable, as to be preferable to stone for building. From the details given by Vitruvius, who flourished in the reigns of Julius and Augustus Cæsar, it appears that crude bricks of two kinds were anciently used; the one made of a mixture of sand and argillaceous earth, very similar to that we now employ; the other a mixture resembling our mortar, being a composition of lime and sand, or of lime and other substances, forming a kind of stone. The first kind required and received a long desiccation, as they were frequently large in their dimensions, and if not thoroughly dried before having been used, they would afterwards have shrunk, to the injury or destruction of the building.

Argillaceous bricks, when used unburnt, must contain a much smaller portion of sand than those which are burnt, as they would otherwise readily absorb moisture, and soon crumble; and this circumstance will account for the great length of time required to dry them. The purest natural clay would probably be the best; and this, if repeatedly pressed during desiccation, would acquire a degree of solidity, which would enable it to withstand the vicissitudes even of variable climates. In hot and dry countries, as in Arabia, where it seldom rains, crude bricks, of a less firm texture, may last for ages, with little or no apparent change in their appearance.

Ancient ordinances are still extant, which declare the dimensions that the bricks ought to have, as well as the proportionate thickness and elevation of the walls; and also the length of time during which crude bricks must be allowed to dry. At Utica this was extended to five years, a less period not being accounted sufficient to ensure that perfect stability which should preserve the plaster-work, or other incrustation with which they were to be covered, from a liability to be loosened and separated. The bricks in general use among the Romans were a foot long, and half a foot broad. Two sorts were used by the Greeks, the one measuring about a foot, and the other about fifteen inches on every side. The first were used in private, and the latter in public buildings.

In Babylon, and other places, a kind of bitumen was used as a cement for the bricks; and this, as it became very hard, and was impervious to moisture, had a powerful tendency to protect the crude argillaceous bricks from the influence of atmospheric changes.

To the second kind of crude bricks, which was made with mortar, may be given almost every degree of hardness; from that of the most fragile, to that of a very hard and durable kind of stone; according to the goodness of the lime, and the qualities of the other materials entering into their composition.

The Romans regulated with great care the preparation which should be given to mortar before it was employed *; and M. Delafaye has pointed out many mortars proper for the formation of these bricks, or factitious stones; as, for example, one measure of lime, slacked dry, and three measures of pounded stone, sifted, to which add the necessary quantity of water, and work the whole well up together; or, secondly, one measure of fine dry sand, free from clay, one measure of sifted stone-powder, and one of dry slacked lime, with just water enough to make them unite, and the whole then well worked together. Thirdly, five parts of rough sharp sand, two parts of fresh burnt dry slacked lime, with just water enough to render it adhesive, but no more. Fourthly, one measure of dry pulverized clay, kneaded with oil, eight measures of fine clean sand, or of pulverised and sifted stone, or of the two combined, and two measures of recent quick-lime, moisten the eight measures of sand or stone, and work them up like soft mortar, bruise the lime fine, and add it thereto with a trowel or pestle, knead it well up together, adding water if necessary to render the whole adhesive, but no more than is requisite for this purpose; when perfectly mixed, and and whilst yet warm from the slacking of the lime, add the clay which was kneaded with the oil, and beat them till thoroughly incorporated. This mortar must be quickly used, as it will speedily set, and become impervious to moisture.

In Piedmont, factitious stones are made, which they call *prisms*, from the form given to them, which is that of

* In lately removing the foundations of Burleigh House, latterly Exeter 'Change, the labourers frequently encountered those of a more ancient structure, most probably Roman, as the bricks composing them were much smaller than those used in the building of Burleigh House, and were of a red colour. The mortar also had coarse grains of a white substance incorporated with it, as though the quick-lime used had never been *slacked*, but only *coarsely powdered* when forming the mortar. The consequence was, that it cost the labourers infinite time and trouble to break up these foundations with their pick-axes, as was very frequently witnessed by the Editor, from the windows of his apartments opposite to them; and also that they broke up bricks and mortar in masses mingled together, the mortar and the bricks being both equally hard.—EDITOR.

a triangular prism, as they are principally intended for the projecting angles of walls. They use an excellent *aqua-durant* lime, which is slacked in the usual way, and left for four or five days to complete the process; it is then placed in the centre of a hollowed heap of sand, unequal in grains from the ordinary size, to that of coarse gravel; the whole is then carefully mixed. A triangular trench, of indefinite length, is prepared in a situation free from the risk of inundation, the sides of which are carefully smoothed by the aid of a trowel and some water. The prism is then formed by successive beds of the mortar, and pebbles of uniform size,, equally distributed. The prism is then covered with the earth which had been dug out, to the thickness of nearly a foot. The proportions of the ingredients used, are about fourteen parts of lime in a pasty state, ninety parts of the unequal grained sand, and twenty of the pebbles. These prisms commonly lie buried for three years, at the end of this time they will bear very heavy loads, and when let fall upon each other, from a height of twenty feet, or upwards, they may be chipped at the corners, but will not be broken.

From the ordinary kind of lime, good small bricks of this description may undoubtedly be made; but for factitious stones of large size, those limes must be used which solidify quickly; as the magnesian lime and puzzolana of Italy, Parker's Roman cement, and the other hydraulic limes of England. Moulds of the various forms may be made, and the artificial stones may be also consolidated, by beating and pressure, while yet partially moist.

Delafaye is of opinion, that to the numerous other proofs of the ancients having made large artificial stones for many of their edifices, the great Egyptian pyramids may be added. The stones which form the facings of these structures, he unhesitatingly declares to be of this kind. They have all the same dimensions, and are about thirty feet long, four broad, and three in height. They have no connecting cement, and fit so closely, that the blade of a

knife cannot be inserted between them. A fragment, when sawn or broken, perfectly resembles factitious stones, being without any binder, such as usually appears in the naturally compounded stones. A fragment of a similar stone, which was taken from the ancient buildings of Alexandria, contained a piece of brick, which had evidently been burnt in the furnace. There is no quarry, within a great distance, from which the stones could have been obtained; and it is also thought, that their weight, about 65,000 lbs. each, is so immense, as to render it highly improbable that they could have been transported, and afterwards raised to a great height.

Several other reasons are urged, to prove the correctness of the opinion, that these, and other large masses of stone, are factitious. In more modern buildings, it is declared that artificial stone has been employed; the pillars of the church of St. Amand, in Flanders, and the columns of that of Vezelai, in Burgundy, are, it is said, acknowledged to be of this kind.

We shall not introduce the reasoning of those who deny or controvert the opinion of the factitious character of these stones, as we have now nothing to do with this controversy; our only object being to show that such stones were probably made by the ancients; and that certainly we have the materials, and are acquainted with the processes by which they may be formed. These materials are various, and require to be differently treated. Those which set slowly, may be consolidated and improved, by beating and pressure; those which set quickly, like Parker's Roman cement, and some others, must be allowed to do so undisturbed. Some kinds should be permitted to consolidate when shut up in a damp situation, or covered up in the ground. Experience and observation, in fact, must determine the best mode of procedure in each particular case.

Note.—We have transcribed this Article from "The Franklin Journal." The Editor, Dr. Thomas P. Jones

E 2

having abstracted it chiefly from M. Hassenfratz's paper on the subject.

X.—On the Progress of Inventions connected with Navigable Canals.

(Continued from Vol. V. page 189.)

THERE is a great variety in the size of locks, as the canal is navigated by large or small boats. The sea-lock, near Inverness, on the Caledonian canal, is 180 feet long, forty feet wide, and twenty feet deep, besides the lift, or difference of the levels, of eight feet. The locks on the Derby canal are ninety feet long, fifteen feet wide, and eleven feet deep, including the lift of eight feet. These on the Leeds and Liverpool canal are seventy feet long, fifteen feet wide, with nine feet lifts. In passing a lock, every ascending boat requires a quantity of water just sufficient to fill the lock from one level to the other, together with a quantity equal to the weight of the boat. But a descending boat expels a quantity of water in the upper canal as it enters the lock, which is retained by the upper gates, equal to the weight of the boat and its lading. To make a double passage then, or for two boats, equally loaded, to pass in opposite directions, it requires a quantity of water equal to the area of the lock, multiplied by double the lift. This may, perhaps, be taken without any great error, on locks of medium size, at 320 tons. A necessary precaution in fixing the sites of locks, is to avoid placing them too near together, for in such case, the water let out of the upper lock, on the passage of a boat, will overflow the banks of the subjacent level, and not only be lost, but injure the works. The locks should be all of equal height, so that the water used at the upper lock, or an equal quantity, may serve for the passage of the boats through the lower lifts.

A great many contrivances have been proposed, either as improvements of the common lock, or a substitute for it.

If in a lock of the common construction, we consider the water which is let down from one level to another, in the light of a force expended to produce a given effect, which is the elevation or depression of the boat and its load, there is a loss of the acting force, unknown in any other mechanical operation. Thus, to raise a boat and load, weighing thirty tons, through eight feet, it will in general require 180 tons of water, falling through an equal space. But in descending boats the effect is *negative*, and the disparity between this and the force is yet more striking. If, therefore, in transferring boats from one level to another, the economy of force only were considered, the inclined plane, arranged as it is in England, must be very advantageous, the expence of force being, in theory, merely the small quantity required to overcome the friction of the machinery, and the inertia of the moving masses.

Mr. Fulton, who paid much attention to this subject in the early part of his life, says, "I do not hesitate to prognosticate the annihilation of lock canals by improved science, in like manner as improvements in machinery render the old apparatus useless." (Fulton on Canals, page 28.) A bold prediction, which seems yet very far from being fulfilled. This gentleman was then very highly in favour of the inclined plane as a substitute, not only for locks, but for aqueducts. In his work, published in London, in 1796, he has detailed fully his plans. His machinery, besides the inclined plane, may be described in general terms, as consisting of an endless chain, running over wheels, fixed, one at the top, and one at the bottom of the plane; to this chain are to be attached two boats, in such a manner, that the descending boat assists in dragging up the ascending one. The small force which may be necessary to pass the boats so arranged over the plane, is to be supplied by a vessel of water, descending through a shaft from the upper canal. The boats are to be small, and they are to be provided with wheels, to diminish the friction in passing over the planes. Various other modifications of the inclined plane have been proposed;

some of which, as has been before observed, are advantageously used in peculiar situations. None of them, however, are thought, at the present time, likely to become a general substitute for the lock.

Another contrivance, called the balance-lock, consists in floating the boat into a case or vessel, at the termination of one canal, and moving it vertically, by machinery, to the other canal. There are two of these cases suspended over the same pullies, on an axle, so that they at all times balance each other; and that, whether one or both contain boats; because they are so executed, that a boat, on entering, expels from the case a quantity of water equal to its own weight, and the same quantity returns into the case when the boat is passed out. But one of the most ingenious machines which has been invented to avoid the loss of water, is described in the Repertory of Arts, vol. I. page 81, first series. It may perhaps be considered as a modification of the balance-locks previously invented; still it exhibits great originality and inventive powers in its authors. It is necessary in this, as in other balance-locks, that the two canals terminate in the same vertical plane; the end of the upper canal being closed by gates at its termination. Things being in this state, a well or pit is sunk at the head of the lower canal, of a depth somewhat exceeding the difference of elevation between the two levels. This pit is filled with water, and a diving chest, or buoy, sufficiently strong to bear a heavy external pressure is then made, and put afloat over the pit. On the top of this chest several strong posts are erected, high enough to reach the bottom of the upper canal. These posts support a cradle, which is open above, and nearly filled with water, and having gates at both ends, through which the boat may pass in and out. The specific gravity of the buoy must be so much less than that of its surrounding water, as to be just able to support the load, consisting of the pillars and cradle, which are fixed to it, together with the canal b at, and a sufficient quantity of water to keep it afloat in the cradle. When so

loaded, it should be just covered by the water in the pit, where it can move up and down on the application of a very small force. To let down a boat from the upper level, the end of the cradle is fixed by screws to the gateway of the canal, the gates of which, as also those of the cradle at the end next to the boat, are then opened; the boat enters from the canal into the cradle, displacing a quantity of water just equal to its weight, consequently the burden on the buoy is not altered. All the gates are then closed, and the fastenings, which confined the cradle to the gateway, taken off; when on the application of a trifling force to the mass, the buoy descends to the bottom of the pit, bringing the boat to the plane of the lower level. The gates at the end of the cradle are then opened, and the boat passing out, its place is supplied by water from the lower canal.

There is yet another contrivance (Rep. vol. II. page 235) differing considerably from the above, although of the same class. It is a caisson, or diving trunk, made so as to be perfectly tight when the gates at its ends are closed. This floats in a lock between the two canals; the canal boat is received into it, and it is made to descend through the water of the lock, to the plane of the lower canal; when by opening the end of the caisson, and corresponding gates in the lower part of the wall of the lock, the boat is passed out. The ascending motion is obtained by pumping water out of the caisson, which operation is reversed to obtain a descent. In this, and the preceding invention, the manner of passing an ascending boat will be understood, from the operation of descending, which has been described.

In another, and distinct class of contrivances, it is proposed to fill the common lock, by elevating water from a sort of cistern, made near it. To accomplish this, different kinds of plungers are to be used, some of which are very ingenious, particularly those of Betancourt, Steevens, Busby, and Bogaerts. In these the plungers are so counterbalanced, as to be always in equilibrio with the water

in the lock, at whatever height it may be; consequently, the application of a very small force, destroying the equilibrium, produces the rise or fall of the water, as may be required.

(To be continued.)

XI.—*On the futility of the attempts to construct Perpetual Motions. By Dr.* Thomas P. Jones, *Editor of the "Journal of the Franklin Institution."*

It will not be expected, by those conversant with the inquiry, that any thing really new can be offered on a subject which has been so frequently and so ably treated as the inquiry into the possibility of constructing a machine which has within itself a principle of continued motion. There is something extremely fascinating in the pursuit of this object, as is evinced not only by the attempts of a host of tyros in mechanics, but by the persevering efforts of some men of genius and science, who, although they have professed faith in the admitted laws of motion, have yet proved by their works that their faith was not perfect Whilst there is nothing in the known laws which govern the material world, upon which to found the idea of being able to construct a perpetual motion, the time might not be mispent which should be devoted to an investigation of the causes which operate upon the mind in exciting and keeping alive the expectation that such a machine will some day be discovered; but if we possessed the ability fully to prosecute this investigation, it would belong more to a work devoted to moral, than to mechanical, philosophy.

Some of our readers may be ready to exclaim, "but we have always understood, that all philosophers denied the possibility of any such thing." We believe that all who really merit the name of mechanical philosophers, do unite in such a denial; but if this be the fact, the corps is but a small one; for our own observations, together with the

numerous facts upon record which might be called as evidence, go to prove most clearly, that there are but few persons who admit this truth as they admit an axiom; there appears, in general, to exist some mental reservation; some apprehension that if they declare the thing impossible, it may nevertheless happen, that some lucky wight may "hit upon it," and thus ruin their reputation as accurate philosophers!

The subject of mechanics is one which, of necessity, occupies a large portion of the attention of mankind; all the moving powers which we can command, are called to our aid; but into the actual employment and adaptation, there enters much more of practice than of principle. A great proportion of our mechanics are men of observation, intelligence, and experience; and many of them have paid praiseworthy attention to science. But their very pursuits and occupations, although greatly aided by the scientific knowledge they have acquired, forbid them carrying such investigations to a great extent. And we ought not, therefore, to be much astonished, if some of them are occasionally engaged in this fruitless pursuit. To their credit, however, this is now a rare occurrence, as the observations founded upon correct practice must necessarily lead to the same general results as does a correct theory. The constant employment or notice of the various machines which are daily seen in operation, induces almost every man to conclude that he knows something of mechanics. In many of these machines, the cause of their motion is very obscure; whilst the motion itself is not only evident, but so uniform and continuous, as may well lead the ordinary mind astray, and cause the conclusion that the step from some of them to an actual perpetual motion, is but a short one.

There are but few terms in our language which are less definitive than the term science; it embraces almost every department of human knowledge, whether natural, moral, or physical; and it happens, unfortunately, that when

philosophers and men of science are mentioned, the world are not very discriminative; and the opinion of the adept in natural history, or in chemistry, will carry an undue weight in subjects to which he has not attended; and of which, although he is a man of science, he is nearly or completely ignorant. It is in this way certainly, and in this only, that the votaries of science, and the believers in a mechanical perpetual motion, have been identified. On which side were the scientific of Philadelphia arranged, when Redheffer's machine was exhibited at Chesnut Hill? Those who recollect the period, will find no difficulty in answering the question. We believe, that nineteen-twentieths of those who were so esteemed, were either avowed believers; or, as the politicians would say, upon the fence. We know one gentleman who professed, and was believed, to be a man of great mechanical knowledge, who delayed in completing a patent, lest Redheffer's machine should be found to be genuine. We are of opinion, that there is scarcely any other subject so familiarly spoken of, and so little understood, as the principles of mechanics; and no one, therefore, in which quackery is more certain of success.

Let not our readers expect, that, because we have thus freely spoken our sentiments, we are about to demonstrate, that a mechanical perpetual motion is an impossibility; we should indeed be willing to take any particular machine, which might be pointed out to us as such, and undertake to show the fallacy of its claim; but to give a general negative demonstration, is a task which we cannot undertake. It belongs to those who advocate its possibility, to establish a principle upon which it may be made to act; the general practice, however, has been to exhibit a complication of levers, weights, or other powers, which serve to obscure the action of the individual parts, and to claim, for the whole, effects to which these individual parts, taken alone, have no power to contribute.

It has been, we think, truly observed, that to produce a perpetual motion, we must find a body which is, at the

same time, both heavier and lighter than itself, and in which the action and re-action may consequently be unequal. This is manifestly a physical, absurdity; and although many attempts have been made to cheat bodies out of the properties with which nature has endowed them, yet no one has had the hardihood to deprive them of their essence in a legitimate way.

To investigate the laws which obtain in the motion of bodies, would require a treatise of no small length; this, therefore, we cannot attempt; but, nevertheless, think it necessary to offer a few remarks upon some of them; and, particularly, upon the property denominated inertia, and upon momentum.

The very words which we employ to designate a particular thing, are frequently permitted to lead us into error, in consequence of our not restricting our terms according to the nature of the things to which they are applied; thus we frequently use the expression, "the power of inertia;" which may lead to the conclusion, that from this property of matter some power may be derived; although the very term inertia, is intended to express the simple fact, that matter is altogether inactive or powerless. Inertia is a mere nullity; and, therefore, instead of conveying the idea of power, it is intended to express the entire absence rather than the existence, of a property. If this be true, inertia can give us no aid in producing a perpetual motion; for, supposing, for the sake of argument, that gravitation, friction, and a resisting medium, could be placed out of the question; as every single impulse which is given to matter tends to carry it on in a straight line, whatever deflected it must necessarily abstract from, and eventually stop, its motion. All our machines must have either a vibratory, or a curvilinear motion, or they would, from their very structure, soon elude our grasp; any impulse which we give to them, cannot, therefore, be continued, in consequence of the inertia of the matter of which they are composed. But we must also, and at every moment, encounter friction,

and a resisting medium, and in consequence of these, our machine must eventually lose whatever impulse we may have given to it; for although matter is indifferent both to rest and motion, it is not so to impulse, or which is the same thing, to resistance; and whether we abstract from its motion by grains or by ounces, it must eventually cease. Upon this it is unnecessary to dwell, because the fact must be admitted on all hands to be as stated. But if inertia, or the absence of power, cannot give power to a machine, may we not obtain something from momentum? Momentum is the quantity of motion, and is compounded of the quantity of the matter moved, and the velocity with which it moves. The case we have been considering under the head of inertia, is a case of momentum; as we have supposed a certain impulse given to matter, which matter has in consequence acquired motion, and which motion, from inertia, would be continued, were there no counteracting causes. If we give a double velocity to our machine, or mass of matter, as to a wheel, for example, we give a double momentum, or, what is the same thing, a double quantity of motion, and it will only require a double space of time, *cæteris paribus,* to exhaust this motion; we have not, therefore, advanced a single step towards perpetuity. It consequently is not in this way that aid has been sought from momentum, but in one which, although it is equally fallacious, is better calculated to deceive. We have already observed, that the momentum of a body is increased by increasing its velocity, or the space through which it passes in a given time, although its quantity of matter remains the same. Suppose we have a horizontal lever, or bar, with equal weights at each end of it, A and B, supported by a fulcrum between them, and that the fulcrum is but half the distance from A at which it stands from B; when allowed to move, B will therefore preponderate, and will move with a velocity which will be double that of A; that is, it will descend two inches whilst A ascends but one; its momentum power, or quantity of motion, will, therefore, be double.

If now we could cause the fulcrum to change its place, that is, to bring it as near to B as it was to A, and back again alternately, each of the weights would preponderate in its turn, and a perpetual vibration would ensue. How an effect of this kind has been attempted, will be seen upon an examination of some of the plans, to be presented in the sequel.

In many instances, the machines have been made so complex, as to render an analysis of them somewhat difficult, even to well informed observers; this complexity, however, instead of promoting the desired end, only renders a larger portion of foreign aid necessary to produce and continue the motion.

Numerous impositions have been practised by individuals who have pretended that they had made self-moving machines. When deceptions of this sort have been practised, the charlatans have, of course, endeavoured to perpetuate the concealment of their mode of procedure. Most of our readers remember well the case already mentioned, of Redheffer's perpetual motion, as it was called; the question has been frequently asked of us, whether the mode in which he made his machine act, has ever been discovered? We believe it has not; but we could construct a machine, as did Mr. Lukens, in external appearance and motion like his; although we still could not aver that our mode of communicating motion would be the same with his, as we have conceived of more than one mode, and he, probably, had devised another. It was easy to show that it did not move from any of the causes assigned by him, or which were visible on its exterior.

Numerous as have been the contrivances to effect a perpetual motion, but few of them are placed upon record; a circumstance which is by no means surprising, as they have always ended in disappointing the hopes of their projectors. Those who pretend to have succeeded, have not informed us how we may do so, and are therefore not entitled to the slightest portion of credit. Almost the only

machine of the kind which has obtained any celebrity, is the wheel of Orffyreus, of which an account was published by the celebrated philosopher S' Gravesande, in the year 1774. This machine was in the form of a large circular wheel or drum, twelve feet in diameter, and fourteen inches in depth; the whole was very light, being formed of bars of pine-wood, the intervals between which were closed, by being covered with waxed cloth, which served to conceal the interior parts. An iron axis upon which the wheel turned, rested upon two supports. On giving to this wheel a slight impulse, in either direction, its motion was gradually accelerated, until, in a few revolutions, it acquired a velocity of twenty-five or twenty-six turns in a minute. It was placed in a room, in a palace of the landgrave of Hesse, the door being locked, and sealed with the landgrave's seal; and, for two months, it continued its rapid revolutions; at the end of which time it was stopped, to prevent the wear of the materials. S' Gravesande was an eye-witness of the whole operation, and made a critical examination of the external parts, which resulted in a conviction in his own mind, that there was no communication with the adjoining apartments. Orffyreus pretended to be so incensed at the curiosity of S' Gravesande, that he broke the machine in pieces, and wrote upon the wall, that it was the impertinent curiosity of the professor which induced him to take this step. The prince of Hesse, who had seen the interior of the wheel, declared that after it had been in motion for a considerable space of time, there was no appearance of change in its parts; that there were no pieces which indicated fraud or deception, and that its construction was very simple. Orffyreus could never be persuaded to construct another.

This is all the information which we possess respecting this celebrated wheel, and it appears useless to offer any conjecture respecting the manner in which it was moved. It is highly probable, however, that the time had arrived, when it suited Orffyreus to destroy it, to prevent detection,

and preserve his secret. When Redheffer had exhibited his machine for as great a length of time as he deemed it safe to do, he had it packed up for the purpose of sending it to Europe, in the care of two gentlemen, with whom he had formed a connexion, and who were confident that it was a self-moving machine. The war then existing prevented its being shipped; the principal of the two gentlemen alluded to, opened the case, and put the machine together, without the knowledge of Mr. Redheffer; when lo, he found, to his utter astonishment, that the principle of motion had become extinct; and that the causes which had appeared to him sufficient to give it action, had, in reality, nothing to do with it! Mr. Redheffer was also so incensed at the "impertinent curiosity" of the gentleman who dared to open it before its arrival in Europe, that he refused to have any thing further to do with it. We apprehend that there is a considerable degree of similarity between these two cases.

(*To be continued*)

XII.—*On Mr.* Charles Wheatstone's *new Musical Instrument, the Symphonion.*

This instrument, which, in the size of an ordinary snuff-box, comprizes musical tones extending even to the compass of three octaves, with additional semi-tones; is played upon with keys, arranged in an entirely novel manner, so as either to produce single notes, thirds, fifths, or other chords, at pleasure. It is undoubtedly the most portable wind musical instrument ever invented, which is capable of being played upon by the fingers of a performer.

In the portable musical boxes, the springs are acted upon by machinery, but so as to produce a few set tunes only.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since November 26, 1829.

To Francis Westby, of Leicester, in the county of Leicester, cutler; for certain improved apparatus, to be used for the purpose of whetting or sharpening the edges of the blades of razors, penknives, or other cutting instruments Dated November, 26, 1829. —To be specified in two months.

To John Marshall, of Southampton-street, Strand, in the county of Middlesex, tea dealer; for a method of preparing or making an extract from cocoa, which he denominates Marshall's extract of cocoa. Dated December 10, 1829.—In two months.

To Benjamin Goulson, of Pendleton, near Manchester, in the county of Lancaster, surgeon; for certain improvements in the manufacturing of farina and sugar, from vegetable productions. Dated December 14, 1829.—In six months.

To Charles Derosne, of Leicester-square, in the county of Middlesex, gentleman; who in consequence of a communication made to him by a certain foreigner residing abroad, and inventions by himself, is in possession of an invention, for certain improvements in extracting sugar or syrups from cane juice, and other substances containing sugar, and in refining sugar and syrups. Dated December 14, 1829.—In two months

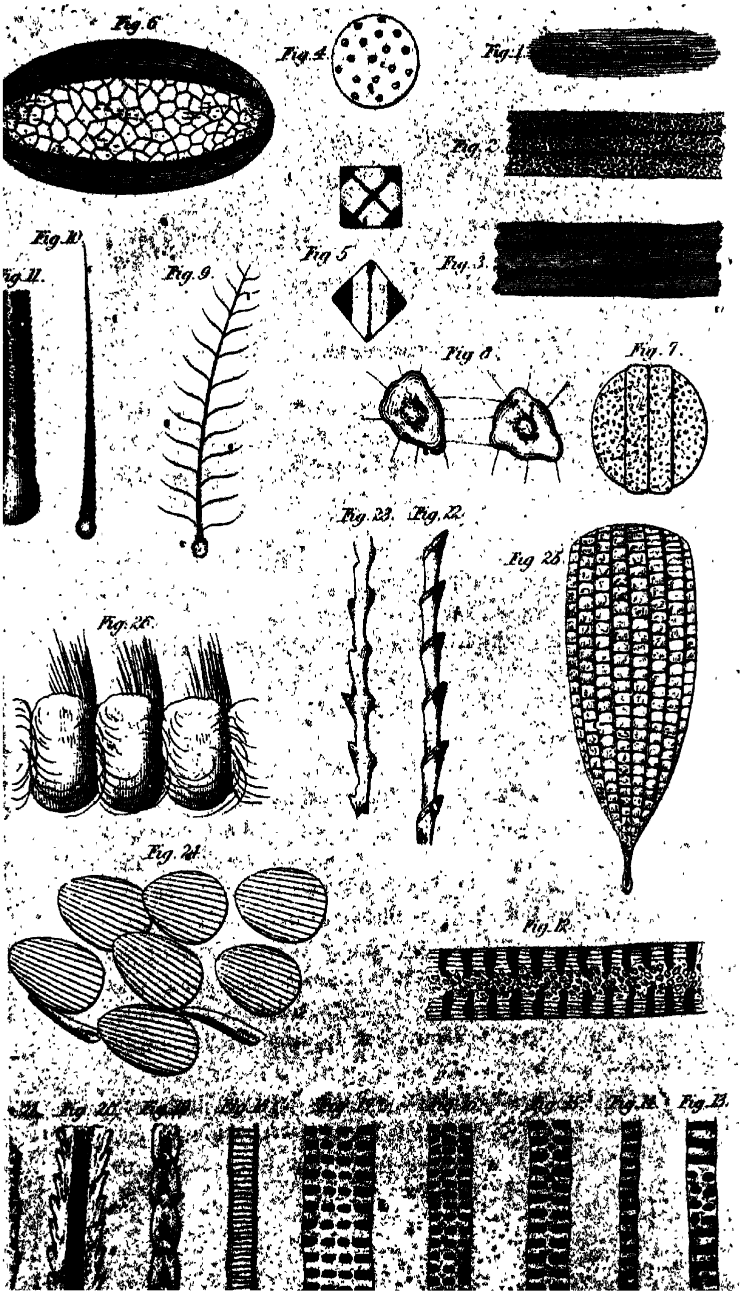
Fig. 6
Fig. 4
Fig. 1
Fig. 2
Fig. 3
Fig. 5
Fig. 10
Fig. 11
Fig. 9
Fig. 8
Fig. 7
Fig. 23
Fig. 22
Fig. 25
Fig. 26
Fig. 24
Fig. 12
Fig. 20
Fig. 13

GILL'S TECHNOLOGICAL & MICROSCOPIC REPOSITORY.

XIII.—*Additional Particulars on viewing the Circulation of the Sap in the Chara Translucens. By* THOMAS CARPENTER, *Esq. With Remarks. By the* EDITOR.

WITH FIGURES.

DEAR SIR, *London, January* 1, 1830.

I WAS so highly gratified with seeing the circulation of the sap in the stem of the *chara translucens*, under your excellent Varley's single microscope, last evening, that I was induced, this morning, to try what effect I could produce with the small portion of the plant you gave me, under my compound microscope.

Having cut off one of the joints, which was the farthest from the root, I scraped off the green bark very carefully, until I had rendered it transparent. I then placed it within some water in a watch glass; in this state, I had the pleasure of seeing the circulation in a very distinct manner (but not equal to the view under your Varley's microscope), the globules proceeding down one side of the stem, and going up on the other side, resembling very much in appearance the slow circulation of the blood, which we have frequently seen in some of the smaller aquatic insects.

Your microscopic readers will now have an opportunity of witnessing this very interesting fact, as almost any well constructed compound microscope will produce the effect.

I imagine that if the other species of *chara*, as well as numerous other aquatic plants, were to be treated in the manner in which I have prepared the *chara translucens*, that the circulation of their sap might also be seen in several of them.

When you are viewing this plant again, I would recommend you also to examine the various animalculi which attach themselves to it. I observed several which were quite new to me, and some of which were of most singular forms. One, in particular, attracted my notice; it was an elegant lively little creature, furnished with a membrane, which it occasionally threw up, after the manner of the nautilus, and which seemed to assist it in its motions in the fluid; and when in that state, it very much resembled that marine animal in miniature; should you observe it, perhaps you will favour your readers with a figure of it.

I remain, dear sir,

Your obliged friend,

To T. GILL, *Esq.* THOMAS CARPENTER.

Remarks. By the EDITOR.

It is very true, that, knowing the circulation of the sap to exist in the *chara translucens*, it may be traced under the compound microscope, as the Editor has done in one made by the late celebrated George Adams, in his possession; but he certainly would never have been enabled to have discovered it by that instrument.

Since his communication in last month's number, the Editor has found that the two portions of the *chara* which he had separated from the plant, and prepared for viewing by the microscope in the manner there described, retained their power of circulating the sap for at least fourteen days after such separation. This is indeed a most surprising fact, and what could not have been expected, as the plant itself had then been gathered at least six weeks; and, indeed, the remainder of it has now lost its power of circulation from decomposition. Mr. Gray informs the Edi-

tor, that the plant is yet to be found, it growing in spring water, three feet in depth, and below the reach of frosts. It is, however, a valuable discovery, that the prepared parts of it, when kept under water, will retain their circulating power so long.

The two portions thus separated, are each not more than three quarters of an inch in length, and about the tenth part of an inch only in thickness. In plate II. fig. 1 represents one of these portions, as being surrounded with a little water, when placed upon a slip of glass, and ready for examination under the microscope. fig. 2 is a magnified view of part of the exterior of it, which is irregularly granulated. And fig. 3 represents the interior of the sap-vessels, as they appear when the sap is seen flowing through them, by altering the focus a little, when the outer granulations disappear, and the inner parts of the vessels appear to be finely ribbed and granulated.

It may be remarked, that the Editor divided the last specimen of the *chara* which Mr. Gray furnished him with, into two portions, one of which he placed in a Wedgewood's mortar, and only just covered it with water; and the other in a tall glass jar, four inches deep in water. The first continued alive; but the other soon became black, and was quickly decomposed.

XIV.—*On the Microscope. By* THOMAS CARPENTER, *Esq. With Remarks and Additions. By the* EDITOR.

WITH FIGURES.

(Continued from page 8.)

DEAR SIR, *London, January* 10, 1830.

ACCORDING to the promise I made in my last letter, I now send a variety of objects for your microscope, which I trust, on examination, you will find interesting.

I have before observed, that the farina of various plants

affords abundant employment for the microscope; the whole of those I now send may be viewed either as transparent or opaque objects; the latter method, however, I prefer, under high magnifying powers, inasmuch as the fine colours are preserved, as well as the shape and characters in each species.

Mr. Needham has pointed out a very interesting method of viewing the expansion and bursting of the various globules of farina, by placing a few of them within a drop of water, on the stage of the microscope; and when at its proper focus, by attentively observing, they will be seen to burst, and discharge an apparently dark fluid, but which is in fact composed of numerous minute globules, that tend to the fertilization of the seed contained within the plant. For much interesting information on the farina, I beg to refer you to Stillingfleet's preface, page xxx., and also to page 58; also to Derham's "Physico Theology," vol. II. page 383; and for the experiments made by Needham, see his work on the subject, page 60.

Among the various kinds of farina I have sent, you will find some from the sunflower, the hollyoak, the marvel of Peru, the blue bell, garden flag, strawberry, orange flower, arbutus, moth flower, garden mallow, convolvulus, palm tree, tulip, Canterbury bell, tyger lilly, white lilly, Guernsey lilly, salvia coccinia, scarlet fuschia, major convolvulus, and larkspur. These are all placed between slips of glass, and among them will be found some which I have tried Mr. Needham's experiments upon, and succeeded in producing the effects above described, which you will perceive are still very visible, on your examining the same under your microscope.

With these you will also receive three cast skins from spiders, on which you will observe curious hairs, some of them of a herring-bone shape; other hairs branching out from them. A few fine scales, taken from the head of a lepisma, are also in the sliders containing the cast skins of the spiders. I likewise send you some hairs, placed be-

tween glass slips, which came off different species of the rat, mouse, and bat, from those mentioned in my last letter. And between one of these glasses, you will find a very delicate and beautiful wing, taken from a cynips, with a small portion of its abdomen, in which will be seen numerous minute blood vessels; and, in the same glasses there are two scales taken from a young chameleon, possessing curious characters. There are also, between other slips of glass, some exquisitely formed crystals, from the salt of amber; the configurations in these you will find highly interesting, and they would form an elegant object under the solar microscope.

You are no doubt aware, that the earwig is possessed of wings, which are both large and elegant; and that even one of them, when extended, will nearly cover the whole insect. The elytra or wing cases are short, and extend only partially down the body. The wings are concealed beneath these, they are somewhat of an oval shape, and, when extended, are nine or ten times as large as the elytra. I herewith send you a specimen in the pupa state, in which you will observe the rudiments of the wings and wing-cases; and likewise another in the perfect state, with the wings fully expanded, as they are when the insect is in the act of flying; also a single wing, placed between talc sliders. There is a great degree of elegance displayed in the manner in which the insect folds the wings beneath the elytra. They are first closed up lengthways from a centre, close to the body, like a fan; and afterwards refolded across, in two different places; one about the middle of the membrane, and the other at the centre, from whence the first folds proceeded. By this means, the wing is reduced into a small compass, proportioned to the size of the elytra, under which it is to lie.

It is a circumstance extremely singular, that, unlike those of most others of the insect tribes, the eggs of the earwig are hatched, and the young ones fostered by the parent. In the beginning of the month of June, M. De

Geer found under a stone, a female earwig, accompanied by many little insects, which evidently appeared to be her own young. They remained close to her, and often placed themselves under her body, as chickens do under a hen. He placed the whole in a box of fresh earth; they did not enter the earth, but it was pleasing to observe how they thrust themselves under the body, and between the legs, of the mother, who remained very quiet, and suffered them to continue there sometimes for an hour or two together. To feed them, this gentleman gave them a piece of a very ripe apple; in an instant, the old one ran upon it, and eat it with a good appetite; the young ones also seemed to eat a little, but apparently with much less relish. On the eighth of June, he remarked that the young earwigs had changed their skins; and he also found the sloughs that they had quitted. This casting of their skins produced only a slight change in their figure, yet it evidently brought them nearer in shape to the perfect insect.

At another time, about the beginning of April, he also found a female earwig under some stones, placed over a heap of eggs, and of which she took all the care imaginable, without ever forsaking them, He took both the female and her eggs, and placed her in a box half filled with fresh earth, and disposed the eggs up and down in it. She, however, soon removed them, one after another, carrying them between her jaws; and, at the end of a few days, he saw that she had collected them all into one place, upon the surface of the earth, and remained constantly upon the heap, without quitting it for a moment, so that she seemed truly to sit for the purpose of hatching her eggs. The young were produced about the thirteenth of May; in figure they were similar to those before mentioned; but at the birth they were all white, except towards the tail, where a yellow matter was observable through the skin; and the eyes and jaws were reddish. He kept them in the box with their mother, feeding them from time to time with pieces of apple, and saw them grow every day, and cast

their skins more than once. The mother at length died, and her progeny devoured nearly the whole of her body. The little ones that died also underwent the same treatment. M. De Geer, however, conjectures that this only took place from the want of other food, as he had neglected to supply them regularly with nutriment. On the twenty-third of July, only one remained alive; it was full grown, and then in the pupa state.

This insect, though in its nature extremely harmless (except, indeed, to the fruit and vegetables in our gardens), has unaccountably fallen a victim to human cruelty and caprice, originating from the mistaken idea that it introduces itself into the ear, and from thence penetrating to the brain, occasions death. We cannot help expressing a wish that persons who entertain such erroneous ideas, would be convinced that the wax and the membranes of the ear are a sufficient defence against all its pretended attacks upon this organ. It lives indeed among flowers, and frequently destroys them; and when fruit has been wounded by flies, the earwigs also generally come in for a share. In the night, they may be often seen in amazing numbers upon lettuces, and other esculent vegetables, committing those depredations that are often ascribed to the ravages of snails or slugs.

We are indebted to many eminent naturalists for the singular discoveries which, by their researches, they have made in the works of creation. Many of them have devoted the best part of their lives to watching the economy of insects; and by such means, have been enabled to hand down to posterity many curious and wonderful instinctive faculties, evinced in these despised creatures, towards the protection and preservation of their offspring. Huber, in order to give an accurate account of the habits and manners of ants, formed an ant's nest in his room, and prevented their leaving it, by making a trench around the nest, and filling it with water; he also fed them until they became domesticated, after which, they were permitted to

go where they pleased, and to forage for themselves. They soon became attached to their nest. By these methods, he had an opportunity of examining the internal construction of the nest at his leisure, and by comparing therewith the nests made by others in a wild state, he was enabled to write with accuracy upon the subject. He also fitted up a place in which he kept insects of various species, and stored it with plants and food, proper for their sustenance; by which means he was enabled to watch and note down the various changes they underwent from the egg until they arrived at their perfect state. Of many of the changes stated by him and other naturalists, I have had frequent opportunities of ascertaining the correctness. A great part of my time, while I resided in the country, I spent with much pleasure to myself, in observing the habits of these very interesting creatures; and, instead of finding the time to hang heavy on my hands, I have always found a pleasure in examining the cabinet of nature contained within a garden or field; and very frequently, when I have been contemplating the beauties which some of the insect tribes possess, I could almost have imagined them to have said, "It is God who hath made us; then give the glory unto our Creator."

A friend once asked me how it was possible that I could spend evening after evening shut up within doors in the winter? He himself, he said, should be moped to death, for want of employment. My reply was, I have such numerous resources within myself, that the longest winter's evening, or even an hundred such, would never hang heavy on my hands, as I possessed many books of entertainment as well as of information; that I also occasionally tried experiments in optics; but that my chief resource was in contemplating the works of Nature, under the microscope; by the use of which instrument, I had the pleasure of looking, as it were, into an invisible world.

To state one instance only, out of many, appertaining to the use of the microscope, I had only, on my return from a

walk or a ride, to bring home a bottle filled with water from a pond, and I should find ample employment for a long evening, in the examination of a few only of the numerous species of animals contained in it. In some, I should see such complicated machinery displayed in their formation, as to excite both delight and astonishment. In others, such curious and singular forms, that were I to attempt to describe them, it would appear like the imaginings of a disordered fancy! In many, the motions of their intestines, the pulsations of the heart, the circulation of the blood, and their methods of seizing and devouring their prey, were all distinctly seen; and yet many of these were scarcely visible to the naked eye; others were even many thousand times less than a grain of sand! And still each created being had its wants provided for, and all had some important duty to perform in the great scale of creation. And whilst I was thus contemplating these wonders, my mind was lifted up to their Creator and mine, with feelings of gratitude for his goodness, in the protection he had afforded to me throughout the day, and the pleasure he had permitted me to enjoy in viewing these his minute yet wondrous works!

The exquisite beauty with which the wing-cases of several of the beetle tribe of insects is adorned, surpasses any description that I can give. Mr. Kirby, in the introductory letter to his valuable work on Entomology, thus observes: "Insects, indeed, appear to have been Nature's favourite productions, in which to manifest her power and skill; she has combined and concentrated almost all that is either beautiful and graceful, interesting and alluring, or curious and singular, in every other class and order of her children. To these, her valued miniatures, she has given the most delicate touch, and highest finish of her pencil. Numbers she has armed with glittering mail, which reflects a lustre like that of burnished metals; in others, she lights up the dazzling radiance of polished gems. Some she has decked with what looks like liquid drops or plates of gold

and silver, or with scales which mimic the colour, and emit the rays, of the same precious metals. Some exhibit a rude exterior, like stones in their natural state; while others represent their smooth and shining faces, after they have been submitted to the tool of the polisher. Others, again, like so many pigmy Atlasses, bearing on their backs a microcosm, by the rugged and various elevations and depressions of their tuberculated crust, present to the eye of the beholder no unapt imitation of the unequal surface of the earth; now horrid with misshapen rocks, ridges, and precipices; now swelling into hills and mountains, and now sinking into valleys, glens, and caves; while not a few are covered with branching spines, which fancy may form into a forest of trees." "To follow the insects that frequent a garden from their first to their last state, and to trace all their proceedings, would supply an interesting amusement for a long life, and, at its close, would still leave much to be done by our successors; for where we know thoroughly the history of one insect, there are hundreds concerning which we have ascertained little besides the bare fact of their existence."

In order to illustrate some of the foregoing remarks, I have sent for your examination, detached portions from the wing-cases of various species of buprestis, curculio, cantharis, carabus, cicendela, chrysomela, and lytta, together with several specimens of wings from lepidopterous insects. Among the former, you will find two species of the genus *thanatophilus*. The undersides of the wing-cases of these insects are very curiously marked, and possess fine colours. There is also a small insect, the *stenus biguttatus*, which, on examination, you will find granulated in a very singular manner. And in some species of the genus *chrysis* you will find much to admire, both in their colours and in their markings. I have likewise sent you the wing-cases and other parts of the coat of a *curculio imperialis*. The exquisite colours reflected from the scales which adorn the exterior of this insect, are so vivid, that I have been informed

by persons who have seen them in a living state, in the Brazils, that, when the sun is shining upon them, they are so glaringly brilliant, that it dazzles their eyes to look on them! Accompanied with these, I likewise send a small piece, cut from the wing of a foreign butterfly, which is covered with minute brown scales, and is also studded over with minute green ones, elegantly embossed, and so interspersed, as to appear like brilliant stars in the firmament. Last summer, I placed a few blood-worms (as they are termed by anglers, but which are, in fact, the larva of a species of gnat) in a glass vessel, together with a small quantity of moss and water, in order to breed the perfect insect. Several of these larva underwent their change into the pupa state; and, from some of these, I obtained fine specimens of the gnat, *chironomus plumosus.* I dissected the proboscis of one of these insects, and found within it several instruments for piercing and sucking the blood. These I have displayed, placed between two slips of glass; they are exceedingly slender, and very finely pointed and serrated. There are also between the same glasses, several minute scales, which came off the proboscis and the antennæ, and are interesting test objects.

In contemplating the power and greatness of the Deity, as manifested in these minute specks, I have often been led to dwell upon the pious words of one of our most inspired poets, Milton.

> "These are Thy glorious works, Parent of good,
> Almighty! Thine this universal frame,
> Thus wondrous fair; Thyself how wondrous then!
> Unspeakable, who sitt'st above these heav'ns,
> To us invisible, or dimly seen
> In these Thy lowest works; yet these declare
> Thy goodness beyond thought, and pow'r divine."

I am, dear sir,

Your's, very sincerely,

To T. Gill, *Esq.* THOMAS CARPENTER.

Remarks and Additions. *By the* EDITOR.

In plate II., fig. 4 is a magnified view of one of the globules of the farina of the marvel of Peru, which is of a spherical form, and is marked with circular spots, thinly interspersed over its surface, and which surface is also roughened.

Fig. 5 represents two of the nearly square, and curiously marked portions of the farina of the arbutus, or strawberry tree, highly magnified.

Fig. 6 a highly magnified view of one of the oval portions of farina of the tyger lilly, and which is beautifully reticulated all over its surface.

Fig. 7 a highly magnified view of one of the globules of the farina of the *salvia coccinia,* or scarlet sage, surrounded with its zones or belts; and as described in vol. IV. page 199, when exhibited to us by Mr. Lister, under his Mr. William Tulley's excellent achromatic microscope. Mr. Lister furnished this beautiful object, as well as the triangular farina of the *fuschia coccinia,* or scarlet fuschia, highly magnified views of which are given in fig. 8, to Mr. T. Carpenter; as likewise other curious portions of the farina of various plants, selected by him, and mounted between glass slips, as transparent objects for the microscope. The portions of triangular farina of the *fuschia coccinia,* are connected together by exceedingly slender filaments, a circumstance which the Editor has also observed in other kinds of farina.

Fig. 9 is a magnified view of one of the compound hairs on the exuvia of a spider, which Mr. T. Carpenter terms herring-bone shaped. Fig. 10, a single hair, which is jagged all over like a rasp, and as shown in fig. 11, which is a still more highly magnified view of a part of it; this curious formation was also first pointed out to the Editor's notice by Mr. Lister, and as is mentioned in vol. IV., page 199.

Fig. 12 is a highly magnified view of part of a hair of a

rat, which, besides the dark coloured spots proceeding from each side towards the centre of it, has a sort of pith, of a vescicular structure in the middle of it.

Figs. 13 to 21, exhibit highly magnified views of various hairs cut from different parts of the skin of a mouse, by Mr. T. Carpenter, and mounted between glass slips, as transparent objects for his microscope. These exhibit a singular proof of the vagaries of Nature, in the structure of these her minute works. In fig. 13, a hair is seen as being alternately striped across and spotted. Fig. 14 is another and narrower hair, marked with bars all across it. Fig. 15, a broader one, marked with two rows of spots proceeding from the edges towards the centre of it, but not meeting each other. Fig. 16 is another hair, having rows of three spots each, extending across it. Fig. 17, a hair with a row of dark spots on each side of it, and two vescicles between them. Fig. 18, a hair with two plain bands running along its edges one on each side, and barred across between them. Fig. 19 has a very singular structure, resembling a kind of plait. Fig. 20 has deeply serrated edges, and a vescicular kind of pith along the middle of it. And fig. 21 is a hair, which, besides being barred across, has its edges serrated, in a manner approaching in resemblance to that of the hair of a bat.

Fig. 22 is a highly magnified view of the hair of a bat, which has been thought to be formed in a screw-like manner; but fig. 23, which is another of these hairs, likewise shown as highly magnified, does not appear to justify that supposition.

Fig. 24 represents several highly magnified scales, which adorn a foreign curculio; these have an opalline appearance when viewed as opaque objects, and they are also curiously furrowed like shells. Two stout white hairs are also shown, which accompanied the scales.

Fig. 25 is a highly magnified view of one of the brilliant though minute green scales or feathers, which are thinly interspersed amongst numerous brown ones, with which the

wing of a foreign butterfly in Mr. T. Carpenter's possession is covered.

Fig. 26 is part of the curious antenna of a moth, in the same gentleman's possession.

(*To be continued.*)

XV.—*On a new variety of Borax, for the use of Jeweller's, &c.* *.

THE artisan, for whose benefit we professedly write, frequently complains that we use the terms employed by the scientific chemist, and do not call things by their common names; and perhaps our present labour may be thought liable to the same objection. We think that it is a sufficient answer to this complaint, to say, that bodies are known to the chemist in forms and states, in which they have no common name, and there is, therefore, no choice left, but to mention them by the only names which have been given to them, or to leave them unnoticed. In the present instance, as in numerous others, whilst we introduce terms, unknown to the generality of our artisans, we furnish him with the means of preparing that which may be useful to him; although we may not instruct him as regards the play of affinities, and the combination of the atoms which constitute this new substance.

Jewellers, and other fine workers in metal, prepare their borax for soldering with, by rubbing it upon a piece of flat stone, generally a slate, scored across, both ways, so as to form a sort of teeth, which assist in reducing the borax into very fine particles, when it is rubbed upon them with a few drops of water. Now, the ordinary borax is apt to crumble at the edges of the lumps or crystals, in this operation, and small fragments of it thus become mixed with the finer parts, producing not merely inconvenience, but sometimes causing the metal to melt in considerable portions, to

* Abstracted from a Memoir in the *Annales De Chimie.* By the Editor of the Franklin Journal.

the great loss of the workman *. Borax in the new form is entirely free from this defect, for, whilst it is not too hard to rub freely upon the stone, it is yet sufficiently solid and tenacious to prevent the crumbling away, so much complained of.

This new species of borax, differs chemically from the ordinary kind, in the water of crystallization which it contains, this being precisely one-half the usual quantity. This difference in its chemical constitution, is accompanied by corresponding differences in its other properties. Instead of crystallizing in the form of a prism, of four or six sides, it assumes that of a octahedron. Its density is very much increased, and there is a similar augmentation in its hardness. The common or prismatic borax splits into pieces when exposed to a temperature of 120 degrees; but the octahedral remains solid, when thus exposed. Common borax retains its transparency in a moist atmosphere, and when immered in water, in a dry air, it becomes opaque, in consequence of its efflorescing on its surface. The new kind, on the contrary, becomes opaque when affected by moisture, but remains transparent in a dry situation. To the chemist, the cause of these differences needs no explanation.

The following is the mode of obtaining the octahedral borate of soda, practised by M. Payen. Borax is dissolved in water at the boiling point, the quantity dissolved should be such, as to give to the boiling hot liquid, a density of thirty degrees of the hydrometer of Beaume, which is equal to a specific gravity of 1.26. This will probably require seven or eight parts of water, to one of borax; this, however, is a mere guess, as we have not made any certain

* If borax be gently heated, so that the crucible be only red-hot, it fuses in its own water of crystallization, and bubbles up into a white frothy mass, exceedingly friable, and which may be rubbed to a fine powder with the greatest ease, even between the fingers; in this state, it is preferable to that rubbed in the above manner, as it will not rise up in blisters, as usual. The Editor has lately been informed, that the watch case manufacturers rub a little *sandiver* or *glass-gall* up with their borax, in order to lessen its tendency to rise up in blisters, and which defect causes it to displace the small particles of solder. EDITOR of the *Technological Repository*.

experiments or calculations on the subject. The solution is then allowed to cool quietly and slowly; when it has descended to nearly 170°, it will begin to deposit the octahedral crystals, and will continue to do so, until it arrives at 130°. At this point the uncrystallized liquid, or mother-water, must be poured off. If this be not done, the whole operation will fail, as the octahedral crystals will become coated and united by borax in the ordinary state, which is deposited as the liquid descends to a lower temperature.

The process of M. Buran differs somewhat from the foregoing, and is calculated only for operations in the large way. His solution is made rather more concentrated, being equal to 32° of Beaume's hydrometer, or about 1.28 sp. g. He then covers the boiler, so as to cause the solution to cool as slowly as possible. If operating upon 1000 lbs. of borax, it is allowed to remain six days, when it is opened, the liquid drawn off, and the mass of borax taken out. The crust which was last deposited, is of the prismatic kind, this is detached by means of a hatchet, from the dense deposit of octahedral borax.

The new kind of borax is intrinsically of much greater value than the ordinary kind, leaving its utility in the arts out of the question. This will be readily understood, when it is known that the water of crystallization in the latter, amounts to nearly 50 per cent.; whilst the former contains but half this quantity. Under the same weight, therefore, we are presented with a much larger quantity of borax.

In laying the two processes before our readers, we have, in the first place, offered to the jeweller, the information necessary to enable him to operate upon a small quantity, for his own use; and by the second process, the manufacturer may supply the market with an article, which will always be preferred, where its superiority is known.

XVI.—*An important Error in the History of Barker's Mill, corrected by a Correspondent to the Franklin Journal.*

SIR, *Newtown, Massachusets, U. S. September,* 1828.

BEING a constant reader of your Journal, I met, in your number for July last, with the description and history of the mill, called Dr. Barker's. About three years ago, my attention was called to the subject, by the account given of that machine, in Nicholson's Operative Mechanic; and being at that time about erecting a mill, for the purpose of pulverizing drugs, and performing other chemical manipulations, I had thoughts of trying Dr. Barker's. I consulted different books, in hopes of finding more facts relating to its use in practice; at length I found Dr. Dosagulier's Course of Lectures on Experimental Philosophy, in the library of Havard College, and which is the work to which Nicholson and others give the credit of affording the first account of this mill; and saw, to my great surprise, that the history given of it there, is entirely incorrect, of which you can satisfy yourself, by referring to Desagulier's work, vol. I., page 453, third edition. He states, indeed, that "now, by Dr. Barker's improvement, the waste water only, from Sir George's ponds, keeps the mill constantly at work;" but the fact is, that the improvement was not the introduction of the mill, commonly called Dr. Barker's, but merely the Breast-mill, with the buckets running in a circular trough, contiguous to the periphery of the loaded quadrant of the wheel. I now quote Dr. Desagulier, omitting only the references to the engraving, "This wheel is nineteen feet in diameter, with twelve arms, and twenty-four ladle-boards, and is so contrived, that the ladle-boards receive their water a little above the horizontal diameter of the wheel, and do not part with it, till they come to the lowest part of the wheel under the centre, where the water would not only be ineffectual, but hurtful to the motion. The contrivance to effect this, is as follows; there is

a circular channel, reaching from the level of the wheel's centre, quite to the under part, exactly square within; that is, the section made through this channel, by a plane passing through the wheel's centre, is every where a square, of eighteen inches the side. The ladle-boards being eighteen inches long, and eighteen inches broad, just pass down this channel without touching, and scarcely lose any water at all (the little that slips by the first ladle-board, going to the second), in going round a quarter of the wheel," &c. It is by no means strange, that a Breast-mill of considerable diameter, and adapted to make the most of the water, without wasting any, should have been of such signal service to Sir George Saville's ponds.

The true history of the machine, that now goes by Dr. Barker's name, may be found in the 459th page of the same volume. Dr. Desagulier says, that "where there is a fall of water not sufficient to turn even an over-shot mill, supposing this fall to be of sixteen, twenty, or thirty feet, it is possible to make it turn a new invented mill, the most simple that was ever made without wheel, trundle, cog, or round. Dr. Barker had this thought, and communicated it to me, saying, that it would be an experimental proof of M. Parent's proposition (that an under-shot water mill does most work, when the water-wheel moves with only a third part of the natural velocity of the water which drives it). I took the doctor's hint and made the following working model of it, which I showed the Royal Society the experiment of, at their last meeting, this summer." From the above extracts it appears, that, in Dr. Desagulier's time, Barker's centrifugal mill had not been tested, except by a working model, and that Barker's Breast-mill did the work, for which the former has had the credit.

This is not the only instance I have met with, of carelessness shown in the compilers of scientific works, copied by one from another, until it is almost impossible to find with whom the error first originated. The error I have here stated, if not corrected, might induce some person, as

it nearly did me, to expend time and money, which might possibly end in disappointment.

S. C.

To Dr. Thomas P. Jones.
Editor *of the Franklin Journal.*

Remarks by the Editor *of the Franklin Journal.*

We are much obliged by the foregoing remarks of our correspondent. We have not Desagulier upon our shelves, but have no doubt whatever of the correctness of the preceding statement. The detection of an error of this kind, is, in our estimation, a thing of no small importance; we have examined other books, in which the mistake complained of is propagated, and have not met with one in which the facts have been correctly stated. It has been the determination of the Editor, to write an article upon the subject of Barker's mill; and if our correspondent will turn to our preliminary remarks, p. 2, of the July number, he will find this intention expressed, and also some opinions given, calculated to discourage the expenditure of time and money on a mill of this description.

It is much to be regretted, that in the art of book-making, there is, in general, so little industry used, that an error committed by a first compiler, stands a fair chance of perpetual succession; as it is almost sure to be fostered by the next in turn. Every man of science has experienced the truth of this to his cost. Whether we should have detected that which has been pointed out by our correspondent, we do not know. The promised article, however, would not have been written without consulting Desagulier's work; as one of the objects we had in view, was to ascertain the respective merits of Barker, and of Rumsey. The article in our July nnmber, was a continuation of a series of Essays, from a foreign journal.

Remarks by the Editor *of the Technological Repository.*

We are glad that this correspondent of Dr. Jones, has at

length put an end to the delusion which has so long existed in favour of Dr. Barker's centrifugal mill; by proving that Desagulier's supposed approbation of it was a mistake! In Nordwall's celebrated Swedish work, on Mechanics, he has placed this mill at the latter end of it, by way of a caution against the use of it; the water indeed, being employed in the most ineffectual manner, and producing the least beneficial effect.

XVII.—*On Colouring Prints, and on Coloured Inks**.

The art of colouring engravings, is very easily acquired, and can be practised by persons who are unacquainted with drawing. Only so much skill is necessary, in the commencement, as shall suffice for the imitation of good examples; and a little practice will then give facility of execution, and improve the taste. As this art is very amusing to children, and furnishes an agreeable occupation to females, we extract from the *Encyclopedia Moderne,* some directions for its performance.

The colouring of books of engravings, and of those which ornament the volumes in our libraries, are usually executed by women; it consists in giving, by means of the hair-pencil, that colouring to printed engravings which shall correspond with the native hues of the objects represented. This art has, in modern times, arrived at great perfection, as may be seen in various beautiful collections of flowers and plants, which have been presented to us, by those who have obtained the greatest skill in this department. The magnificent collection of roses by Redoute; the medical flora of the antilles, by Dècourtils, and many others, might be cited as examples.

This colouring is a kind of bodiless painting, or rather of washed drawing; the tints employed ought to be transparent and thin; those which have the least body, are therefore chosen; or, rather, colours are prepared which are

* From the *Journal des Connoisance Usuelles.*

without any, as those which are obtained from flowers, and which are found to be the most suitable for this kind of work. When it is necessary to take such as are more gross, they are repeatedly washed over, so as eventually to procure their finer particles only.

The blue petals of the iris, afford a green fecula; but this, however, is less beautiful than that obtained from the ripe berries of buck thorn, and which is called sap-green. The berries of the dwarf elder, afford a violet colour, which may be changed to blue, by the addition of alum. There are many other berries, which afford coloured juices; such as the gooseberry, the cherry, the raspberry, the seeds of madder, and the elder. A decoction of the dye-woods is sometimes used, such as that of fustic and log-wood, A yellow is prepared by gamboge and water; a crimson, by carmine and weak gum-water; the colour of water, by verditer, combined with cream of tartar; blue, by indigo and alum, or by Prussian blue; a fawn colour, by tormentil root; a black, by uniting sulphate of iron (copperas) with this last, or by using Indian ink.

All the coloured juices, of which we have spoken, may be brought into the form of cakes; nothing more is necessary but to add to them, when boiled, a portion of fish glue (isinglass), and, afterwards, to allow them to dry in moulds made of card, which have been rubbed over with butter, to prevent their adhesion; by this means, they acquire the consistence of Indian ink, and may be used in the same way.

These colours, when concentrated, may be employed as coloured inks. Among these, one only is employed in common use, in commercial transactions, namely, red ink. Occasionally, green and yellow inks are used; and sometimes, though more rarely, those of other colours. The following are compositions of some of these, which, when diluted, serve well for the colouring of engravings.

Red Ink.—The mode of preparing this ink, recommended by M. de Ribaucourt: infuse four ounces of ground Brazil

wood in vinegar for three days; then heat it to the boiling point, and keep it for an hour at that temperature, after which it must be filtered. Whilst hot, dissolve in it one-third of an ounce of gum-arabic, and the same quantity of sugar, and of alum; allow it to cool, and put it into well-stopped bottles.

An ink of a still more beautiful tint, may be made of a decoction of cochineal, to which ammonia is to be added.

The most beautiful of all red inks, is made by a solution of carmine in liquid ammonia, allowing the excess of the alkali to evaporate, and adding a small portion of colourless gum arabic.

Green Ink.—Klaprotti's recipe for making a beautiful green ink, is the following; boil two parts of verdegris, and one of cream of tartar, in eight parts of water, until it is reduced to one-half. Strain it through a cloth, allow it to cool, and then bottle it.

Yellow Ink.—In a quart of boiling water, dissolve an ounce of alum; add half a pound of French berries, (*Graines d'Avignon*); keep the mixture at the boilingpoint for an hour, strain the liquid, and dissolve in it a little more than a quarter of an ounce of gum arabic.

By following the same process, but substituting a much smaller quantity of saffron for the French berries, a much more beautiful yellow will be obtained. A still more durable colour may be made from gamboge, by merely dissolving it in water, until it is of the shade required.

By means of concentrated solutions of the greater number of colouring substances, inks of every shade may be prepared; a portion of gum is in general required to suspend the colouring matter; and sometimes corrosive sublimate must be added to prevent mouldiness.

XVIII.—*On Preserving Birds, &c., for Cabinets of Natural History.* By Charles Waterton, Esq.

(Concluded from Vol. V. page 366.)

It is now time to introduce the cotton for forming the artificial body of the bird, by means of the small stick, already described. With this stick alone, and the aid of your own genius, you must produce those swellings and cavities, that just proportion, the elegance and harmony of the whole, so much admired in animal nature, but which is so little attended to in forming preserved specimens. After you have thus introduced the cotton, you must next sew up the orifice originally made in the belly beginning at the vent, and keep adding more cotton from time to time, till you arrive at the last stitch, in order that there may be no deficiency there. Lastly, dip the stick into the solution of corrosive sublimate, and put it down the throat two or three times, in order that every part may receive it. When the head and neck are filled with cotton to your mind, close the bill, as in nature. A little bees-wax placed at the point of it, will keep the mandibles in their proper position. A needle must now be stuck perpendicularly into the lower mandible, the use of which will shortly be described. The feet must also be brought together with a pin, and a thread must be run through the knees, by means of which they may be drawn as near together as you judge proper. Nothing now remains to be added, but the eyes. With the point of the stick make hollows in the cotton, within the orbits, and introduce the glass eyes through the orbits. Adjust the orbits to them, as in nature, and they will require no other fastenings.

A close inspection of the eyes of animals will inform you, that the orbits are capable of receiving much larger bodies within them, than those parts of the eyes which appear when in life; so that were you to proportion the eyes to the size which the orbits are capable of receiving, they would be far too large. Inattention to this has caused the

eyes of specimens, in even the best cabinets of natural history, to be out of all proportion. To prevent this defect, contract the orbits, by means of a small and delicate needle and thread, at those parts of them which are farthest from the beak. This may be done with such nicety, that the stitch in each cannot be observed, and thus you will have the artificial eyes to preserve their due proportions.

After this, touch the bill, the orbits, feet, and the place of the oil-gland, at the root of the tail, with the solution, and then you will have given to the preserved hawk every requisite, except attitude, and a proper degree of elasticity, two qualities, which, however, are very essential.

Procure any ordinary box, fill up one end of it with raw cotton, about three-fourths towards the top, forming it into an inclined plane. Then make a moderate hollow in it, to receive the stuffed skin of the bird. Next, take the skin of the bird in your hands, and, after placing the wings in order, lay it upon the cotton, with its legs in a sitting posture. The head will now fall down, that need not be regarded. Now, take a cork, and run three pins into one end of it, so as to form it into the resemblance of a small three-legged stool. Place this cork under the bill of the bird, and thrust the needle which you formerly fixed there into the head of the cork. This will support the head of the bird admirably. If now you wish to lengthen its neck, raise up the cork, by placing more cotton beneath it. If the head is to be brought forward, bring the cork nearer towards the end of the box. But if it requires to be set backwards on the shoulders, then move the cork back.

As, in drying, the back part of the neck will shrink more than the fore part, and thus force the beak to rise higher than you may wish it to be, you may prevent this fault, by tying a thread to the beak, and fastening it to the end of the box, with a pin, or needle. If you choose to elevate the wings, you may now do so, and support them upon cotton; and should you wish to have them still higher, you

may apply a small stick or prop under each wing, and fasten the ends of the props to the sides of the box, with a little bees' wax.

If you would expand the tail, you must reverse the order of the feathers, beginning at the two middle ones. When dry, replace them in their true order, and the tail will preserve the expansion you have given it. If the crest is to be erected, also move the feathers in a contrary direction to their natural one for a day or two, and it will not afterwards fall down again.

Place the box any where in your apartment, out of the influence of the sun, the wind, or a fire, for the specimen must dry very slowly, if you wish to reproduce every feature. On this account the solution of corrosive sublimate is eminently serviceable; for at the same time that it totally prevents putrefaction, it also renders the skin moist and flexible for several days. Whilst the bird is drying, take it out of the box, and replace it in its position once a day. Then, if you should see any part begin to shrink out of proportion, you can easily remedy it. The small covert feathers of the wings are apt to rise a little, because the skin will come into contact with the bones which remain in the wings, you must therefore gently pull the parts which rise up, between your finger and thumb, for a day or two. The skin will then no more adhere to the bones, and the feathers will cease to rise.

Every now and then you may touch and retouch all the different parts of the feathers, in order to render them distinct and visible; at the same time correcting any harshnesses, or unnatural risings or depressions, flatness or rotundity; this is putting the last finish to the specimen.

In three or four days' time the feet lose their natural elasticity, and the knees begin to stiffen. When you observe this, it is the time to give the legs any angles you may wish; and also to arrange the toes, either for a standing position, or to curve them around your finger. If you wish to set the bird upon a branch, you can in a moment trans-

fer it from your finger to the branch, and again remove it to your finger at pleasure.

When the bird is become quite dry, you may pull the thread out of the knees, take away the needle and cork from under the bill, and all is done. Instead of being stiff with wires, as usual, the cotton will have afforded a considerable degree of elasticity to every part of the bird; so that, when perched upon your finger, if you press it down with the other hand, it will rise again. You need not fear that the hawk will now alter, or its colours fade; for the alcohol and water have introduced the corrosive sublimate dissolved in them, into every part, and every pore of the skin, quite to the roots of the feathers. Its use is two-fold. First, it has, as beforesaid, totally prevented all tendency to putrefaction, and thus a sound skin has attached itself to the roots of the feathers; for you may take hold of a single feather, and suspend from it five times the weight of the bird; you may also jerk it, but it will still adhere to the skin, and, after repeated attempts, often break short off. And, secondly, as no part of the skin has escaped receiving particles of the corrosive sublimate contained in the solution; so there is not a spot left exposed to the depredations of insects; for they will never venture to attack any substance which has received the corrosive sublimate.

Corrosive sublimate is the most fatal poison to insects that is known. It is anti-putrescent, and so is alcohol, and they are both colourless; of course they cannot leave any stain behind them. The spirit penetrates into the pores of the skin with a powerful velocity, deposits particles of the sublimate, and flies off. The sublimate will not injure the skin, and nothing can detach it from the parts, where the alcohol has left it. All the feathers likewise require to be wetted with the solutien, in order that they may be preserved from the depredations of moths. The surest way, however, is to immerse the bird in the solution of corrosive sublimate, and then to dry it before beginning to dissect it.

The furs of animals, when immersed in this solution, will retain their pristine brightness and durability in any climate.

If the finest curled feather, from a ladies' head-dress, be dipped into this solution, and gently shaken till it be dry, the spirit will fly off in a few minutes, and not a single curl in the feather will be injured; the sublimate will then preserve it from the depredations of insects. Some years ago, I preserved a bird in this manner in Demerara, it remained there two years. It was then conveyed to England, where it was kept for five months, and again taken to Demerara. After being four years longer there, it was again conveyed to England through the West Indies, and where it has now remained near five years, unfaded and unchanged.

On reflecting that this bird has been twice in the temperate and torrid zones, and remained some years in the hot and humid climate of Demerara, only six degrees from the line, and where almost every thing becomes a prey to insects, and that it is still as sound and bright as when it was first done, it will not be thought extravagant to surmise, that this specimen may retain its pristine form and colours, for years after the hand that stuffed it has mouldered into dust!

Little more remains to be added, except that what has been stated in regard to birds, may be applied to the preservation of serpents, and also to insects, and four footed animals.

XIX.—*Recollections of his Father, the late Mr.* Thomas Gill. *By the* Editor.

(*Continued from page* 18.)

Although the slow motion of the water-wheel answered most completely for actuating the large forge bellows; yet, in the case of grinding and boring gun-barrels, grinding and polishing sword blades, &c., it was quite different;

and, although the water acting by its gravitating power, produced a much greater effect than when wasted in the usual manner of applying it, yet, in increasing the velocity of the machinery, a part of its force was necessarily expended; and it therefore became an object of considerable importance, that as little friction as possible should be created, both in the toothed wheel-work, and in the bearings of the necks or pivots, which were made larger than usual, so as to allow of a sufficiency of grease to be applied, to prevent the wearing surfaces from coming into contact; and the bearings for them to run in were also made of chilled cast-iron. In consequence of these improvements, a single wooden tooth was never required to be added, during at least nine years; and indeed it was a long time before the marks of the chisel, used in accurately shaping the teeth of the cast-iron pinions, were obliterated, a clear proof that but very little rubbing or friction took place in their action. As, however, the water-wheels were capable, if allowed to run with the ordinary velocity, and therefore to place the workmen in danger from the bursting asunder of the grind-stones; so it became necessary to endeavour to guard against this possible evil, by placing a centrifugal governor to regulate the supply of the water to the wheels. The Editor, now thirty years since, invented the form which has since become commonly employed in the construction of the centrifugal governor; namely, that of raising the socket upon the stem of the governor, by short arms connected with it and the longer ones, upon which the weights or balls are applied, in the manner of an umbrella; and which had the advantage of acting in a quicker manner, than when the governor was constructed as usual. However, the rising and falling of the water in the mill-pond, produced such differences in the pressure under the various depths, that it was found impossible to counteract them, and the use of the governor was therefore abandoned; and a number of handles placed within the reach of the workmen, and each communicating with the main levers

of the shuttles, which admitted the water upon the wheels, were substituted instead thereof. The example thus afforded by Mr. Gill, for the first time in his neighbourhood, of economising the expenditure of the water, although at first ridiculed by those who were confirmed in their old habits; began at length to be copied, and has now introduced a better and less wasteful mode of employing it.

Possessed of a forge, actuated by water-power, Mr. Gill was now enabled to convert the ingots of cast-steel into bars under his own direction, and thus to prevent the great injury sustained by cast-steel from over-heating it, as usual. He thus insured its excellence, and particularly by heating the ingots in a hollow-fire, by the flame alone, without bringing them into contact with the pit-coal, to their great injury; and also carefully working them at the lowest heat possible.

In consequence of the French introducing the use of rifles into their revolutionary armies, it became an important object with government to adopt them likewise; and an application was therefore made to Mr. Gill, to enable them to do so. With his usual energy, he accordingly endeavoured to meet the wishes of government, and caused a machine to be constructed, which should be capable of rifling twenty barrels at once; and, indeed, he contemplated the idea of rifling every soldier's musquet! In this great undertaking he was, however, unfortunately for his country, cut off by the hand of death, and never lived to see the machine fully act! It was, however, so nearly finished, that the Editor, after his father's disease, completed it, and its performance surpassed every thing of the kind which had been constructed before.

The barrels had seven spiral grooves cut along their interior surfaces, the effect of which upon the ball, in passing through them, was to give it a whirl around its axis, which greatly tended to preserve a rectilinear direction in its flight. As, however, in the usual mode of rifling, these grooves were irregularly cut, so the ball experienced a considerable

resistance in passing through them, which greatly injured its effect. Now, in this improved machine, all the seven groves were being cut at once, by the action of as many cutters; and no cutter passed more than once down and up the barrel in the same groove, its position being continually changed by the action of the machine, so that it passed into the next groove in succession, and so on continually. By this means, even supposing that each cutter did not act alike, yet, by their continually changing their places, their irregular actions were equalized, and the result was the most perfect similarity amongst the grooves, whereby the ball experienced no impediment in passing along them.

It is difficult to afford such particulars of a necessarily complicated machine, as may be sufficient to convey any accurate idea of its construction. We shall therefore only state, that the spiral movement of the cutters was obtained from a straight bar, mounted on one side of the machine frame, and which was capable of receiving any degree of inclination requisite for altering the obliquity of the spirals or twists in the grooves; that the rods upon which the seven cutters were mounted, had each a pinion of seven teeth affixed upon its end opposite to that upon which the cutters were placed; and that a toothed rack extended across the machine, the teeth of which acted in those of the twenty pinions, whilst the rods carrying the cutters were passing down and up the barrels; the rack being at the same time pressed into contact with the inner edge of the straight bar, or inclined plane above mentioned, by the action of a spring upon its opposite end, the end next to the bar being furnished with a friction roller. And that instantly upon the cutters being brought out of the barrels, the rack ascended upon two inclined planes, which lifted it up, out of contact with the twenty pinions; and whilst in that situation, by an ingenious contrivance, not to be understood by description alone, it was carried sideways, so as to enter the next teeth in succession in each pinion,

upon again descending the two inclined planes to its ordinary level, as before, and thus effected the important changes above mentioned, of the seven cutters in the grooves of each barrel.

As a proof of the perfect equality which existed amongst the grooves, a cylindrical plug of lead, ten inches in length, might be cast upon an iron bar placed within the barrel, whilst melted lead was poured into it, and which of course received upon its surface projecting spiral ribs, corresponding with the grooves in the barrel. This plug might be passed down and up the barrel without impediment, and be then passed into any other grooves at pleasure, in a similar manner. We need hardly say this could not have been accomplished but in consequence of this absolute equality in the grooves.

The fixed part of this machine also held the barrels firmly which were to be rifled; the cutters being mounted in a sliding carriage, which was carried backwards and forwards, by means of a crank, mounted upon a squared part of the outermost axis of one of the great water-wheels, and which crank had a friction roller, acting in a vertical groove, formed in a cast-iron plate, affixed upon one end of the sliding carriage, and thus moved it in an equable and most favourable manner. The sliding carriage was guided in its rectilinear movements by means of ledges, placed upon the sides of the fixed part of the machine, and furnished with friction rollers. The two inclined planes which raised and lowered the rack being mounted upon one end of the fixed frame. Each cutter was a kind of file, toothed upon its exterior face, and was held in a groove, cut in a proper spiral direction, in the cylinder which held the seven cutters; the ends of each cutter being thinned away, so as to lodge underneath a steel ferril or hoop, firmly affixed upon the cylinder; and also under another hoop, which could be removed, when it became necessary to change the cutters; each cutter being also pressed outwardly, by the action of a spring, placed within the groove

underneath it. The faces of each cutter were made rounding, or swelling in the middle, and tapered away towards each end, so as to enter either end of the barrel without catching. And as the ferrils required to be very strong, and yet but of little thickness, so it became exceedingly difficult to form them. And, in fact, it was only accomplished by raising them by degrees out of plates of cast-steel, frequently annealed, in sets of dies made on purpose, and which first raised the edge a little, so as to resemble a frying-pan in miniature, for instance; then another pair of dies raised it still more; and, finally, it was brought into a cylindrical shape. It was now only necessary to cut out the flat bottom, and the cast-steel ring or ferril was thus formed, without any joining, welding, or soldering.

The twenty rods which carried the cutters and the pinions upon their ends, were driven through the barrels by means of pushing-rods, made conical at each end; the one end of each being fitted into a hole formed to receive it, in the centre of each of the cylinders carrying the cutters; and the other end was received into another hole, formed at the end of twenty adjusting and binding screws, which were affixed into one end of the sliding-carriage.

The barrels were adjusted and firmly held in the fixed part of the machine, by means of saddles and adjusting screws; and when they were once adapted to any particular kind of barrel, it was easy to take out and replace them at pleasure, so that numerous barrels might have been rifled in a short period of time.

We believe that we have thus enabled a mechanic, and especially a gun-maker, to comprehend the principles of this excellent machine; and we wish it were in our power to add, that his surviving children were benefitted by their father's great exertions in constructing it. This, however, was by no means the case; for any one possessed of a barrel rifled in it, had only to cast a cylinder of lead in it, after the manner we have above described, and thus to be-

come possessed of a means of rifling other barrels, not indeed equally perfect with those executed in the machine, but much better than usual, and perhaps sufficiently good to answer the ordinary military purposes.

Mr. Gill, like too many other persons, had a great dislike to making his will, and unfortunately delayed it till it was out of his power to do it properly. The consequence was, that his large property was, after his death, disposed of by auction, at greatly reduced prices; and when the proceeds thereof were divided amongst his twelve surviving children, but little came to each one's share. Of these the major part are now dead. The Editor, and his two youngest brothers, being indeed all who have survived out of eight sons.

Mr. Gill was most deservedly a highly popular character in his neighbourhood, both from the great employment he was able to afford the various manufacturers and their workmen in his vicinity, and from the liberality with which he contributed to the support of the numerous establishments in Birmingham for alleviating their distresses and ailments. He was also, as we have shown, greatly esteemed by government, and particularly by that portion of it connected with the ordnance. During the period of the riots at Birmingham, his house, as well as that of his next neighbour, were threatened by the mob, as belonging to John Taylor, Esq., the respectable banker at Birmingham, and who had several houses either burnt, or otherwise greatly injured, by their excesses. In this predicament, however, so far from removing his own property, as he was repeatedly ordered by the mob to do, as they did not wish to injure him, but only the house he inhabited; he, on the contrary, filled it with the valuable effects of his neighbour, who was a dissenter; and the Editor, with others, kept an armed watch, both by day and night, for the space of a fortnight, over the joint property of both. At length, at the expiration of that period, the military arrived from Nottingham, and relieved them from their perilous situation.

Mr. Gill was thrice nominated high sheriff of the county of Warwick, and must then of course either have served the office, or have paid the usual fine. Shortly before the period arrived, however, a serious accident happened to him, which very nearly cost him his life, from the loss of blood it occasioned; and, indeed, for the space of fourteen days, his physician, the late celebrated Dr. Withering, could give his family no hopes of his surviving. At length nature, and an excellent constitution, prevailed; and the first use he made of his returning faculties, was to direct the Editor to write to his patron, the Duke of Richmond, master general of the ordnance, to inform him of the accident, and of his being thrice nominated to the shrievalty; that he had no vanity to feed, but a family of thirteen children; and that, under these circumstances, he prayed his grace to exert his influence with government, both to get him excused from serving the office, and also to remit the usual fine. His grace accordingly complied with his wishes; and he was not only excused from serving, without being fined, but the gentleman he recommended to government was chosen high sheriff in his stead.

Mr. Gill survived the effects of this accident several years, but it produced a lameness in one of his feet, which greatly lessened his activity.

(To be continued.)

XX.—*On an improved Method of making Lithographic Transfers.* *By Mr.* Joseph Netherclift*.

Lithographic drawings were originally made with a peculiar ink, on paper covered with a coat of size, and were then transferred to the stone by warming this latter, laying the drawing on its face downwards, and passing both

* From vol. XLVII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce. The Society awarded its premium of twenty pounds to Mr. Netherclift.

through a rolling-press. Hot water, by means of a sponge, or in any other convenient way, was then applied to the paper, till the coat of size, on which the drawing had been made, was reduced to a soft pulpy state, which allowed the paper to be stripped off, leaving the drawing fixed, by the previous pressure and heat, to the face of the stone.

Many advantages attended this original method, as compared with that which has nearly superseded it; namely, making the drawing on the stone itself: for, in this latter mode, the artist works on a cumbrous unportable slab, and is obliged to make his drawing in an inverted position; whereas, by the use of prepared paper, he had a light and portable material, together with the great advantage of making his drawing in a natural position, which being that to which artists are accustomed, the work was free from stiffness and constraint.

The objection to the method by transfer was, that the lines were coarse, and only adapted to free sketches, being deficient in that fineness and precision required in most works of art, especially those intended for illustrations of objects of natural history, or as specimens of the higher departments of art. The drawings of all such objects are made on the stone itself. The Society, conceiving that it would be a great point gained so to improve the ink and paper, and generally the whole method of making lithographic transfers, as to make it practicable to most of the purposes for which drawing on stone itself is now had recourse to, offered a premium, which was successfully claimed by Mr. Netherclift. The Society do not, however, suppose, that Mr. Netherclift's process is incapable of improvement; but, from the specimens produced before them, and from the unanimous testimony of several very competent judges, they believe that the process which they now make known, will be found to produce work of a very superior quality to the lithographic transfers which have hitherto come under the notice of the public.

Composition of the Materials.

The Transfer Paper is thus made :

Take the following proportions : a quarter of a pound each of tapioca and arrow-root ; boil them separately to the consistence of pastes, and then unite them, and pour a sufficient quantity of hot water into them to make the whole into a thin paste, which must be strained through a piece of muslin : next add a quarter of a pound of flake white, previously well ground in water, and stir it into the paste. The paper, either thick or thin, should be rather porous, or what is called half-sized paper. Then, with a flat camel's hair brush, first lay a coat of common parchment size upon the paper, and let it dry in ; then lay on the above paste, in the most careful and even manner, three several times ; but letting each coat be well dried between each time of laying it on. Thus the whole surface will be properly covered : if, however, there should be any part omitted, the work upon it will be imperfect. As soon as the paper is become dry, it should either be well cold pressed, or be sent to the glazing mill, and be flattened between iron rollers, which clears its surface ; and the glazed part should be on the back side of the paper, which is effected by rolling two sheets together, face to face. The work, drawn on the prepared face of the paper, is, if fine, to be executed with a steel pen, as the specimen is, which is herewith sent ; the dark parts are drawn with a common crow quill.

The Lithographic Ink is composed of equal quantities of yellow soap and shell lac, boiled and burnt together in the usual manner ; with a sufficient quantity of lamp black added, to make it black ; this forms a cake, which is to be rubbed up either with warm or cold water, in the manner of Indian ink. I prefer to use no tallow or bees' wax in the composition of my ink ; and am prepared to show, that the art of lithography, as connected with the ink work, is not founded on the opposite qualities of acid and fat ; for

the above ink requires no acid to neutralize the alkali of the soap in it, the resinous part of which is fixed by the extreme quantity of shell lac added to it. Thus the use of the acid is generally avoided, and the lines are not so liable to be injured as is usual. In extreme cases, however, where a mass of shade is condensed, a little acid may be used with good effect. Nitric acid, diluted with water, is the proper requisite.

The Act of Transferring, is easy: let the stone be moderately warmed; then damp the back of the paper on which the work has been executed, until it lies perfectly flat; take care, however, that no wet touches the work; then lay the paper carefully upon the warm stone, and over it lay flat soft paper, which will absorb the wet on the back of the transfer paper. Now pass it through the press two or three times, with an increased pressure, after which the paper will peel off, leaving the composition it was coated with, as well as the drawing executed upon it, on the stone. Wash off the former, and rub the drawing over with a coat of strong gum arabic water. Lastly, lay it by till it has become cold, and then print from it.

XXI.—*On destroying White Ants, Cock Roaches, Rats, and other Vermin, on board Ships, by Steam*.*

THE destructive ravages of white ants, when they once find their way on board the vessels in India, have long been the bane of that description of property, aggravated, too, by the secrecy with which their operations are frequently carried on, and by the absence of all means of prevention. Property of acknowledged value, to the extent, at times, of a lack of rupees, has become, on the presence of this destructive insect being discovered, almost valueless; since, hitherto, when once known to have infested a vessel, no instance, we believe, has occurred of

* From "*Gleanings in Science*," a journal published at Calcutta; and "*The Edinburgh Journal of Science*."

their ever having been wholly extirpated; thus not only attaching a suspicious character to the vessel, but occasioning continued, and sometimes very heavy and expensive repairs. Indeed it is scarcely possible even to trace the extent of the evil with any degree of certainty. A ship may undergo a very heavy repair of damages, occasioned by the ants, and every possible means may be adopted, with the view to ascertain the existence of further damage, without success; yet a very few weeks may show another part of the vessel to be infested to a great extent, rendering necessary a yet further repair.

It may reasonably be supposed, that such destruction of property would not be permitted to continue, without some attempts at a remedy; of these the most effectual have hitherto been, the application of extreme cold, or sinking.

The former, of course, could only be carried into execution by sending the vessel infested to a cold climate, there to be laid up for winter. Independent of the loss occasioned by the non-employment of the vessel, the remedy has never been, we believe, complete. A stop has been put to their ravages for a time, but a return to a warm country has shown that the insects have not been effectually destroyed; either they have been reduced to a state of torpidity, or, if the living insects have been destroyed, their eggs have not been deprived of their power of production. The same remark may be made in regard to sinking, independent of which, the expense and difficulty attending the operation, render it little better than submitting to the evil itself.

That so obvious a remedy as that of filling a ship with steam, should, in these times, when its employment may be said to be almost universal, have been so long unthought of, is not a little remarkable; particularly when the practice of smoking ships, for the purpose of destroying rats, and other vermin, has long been adopted, and with partial success. The destruction caused by rats on board ship, is only second to that effected by the white ants. Instances

have been known of their eating through a vessel's bottom and decks; while their ravages on the stores, provisions, and cargo, are almost incredible. Nor are these the only vermin with which ships in this country are infested. The cock-roach, and black ant, centipede, &c., if not destructive of the vessel itself, are so of the comfort of every person on board. The first find their way, more or less, on board every ship in India; the second prevail, at times, to an extent almost surpassing belief, on vessels trading to the eastward, which supply themselves with wood in the Straights. The application of steam, to the destruction of these latter insects, is of itself an advantage almost incalculable. It is obvious, that nothing but the most searching, and, at the same time, powerful agent, could extirpate an insect like the common ant. The experiment was first tried in England*, at the suggestion of Captain Ford, late in command of the ship Providence, in this port, on a ship belonging to him, and we understand with success. We believe, that the steam was not applied to the utmost extent of its power on that occasion. It has, however, since, on the representation made by Captain Ford, of the success of the experiment in England, been applied to perhaps as great an extent as it could be with safety; and certainly to a sufficient extent for all practicable purposes, with the most complete success: since that experiment, too, it has been applied on several other occasions.

The first trial in this country was on the honourable company's ship Investigator. The experiment was conducted by Captain Forbes, of the Bengal engineers, and Mr. Kyd, the honourable company's master builder, and, as might be expected in such hands, would appear to have been managed in the detail with the utmost care and attention, affording a secure guide for future operations. The following is an extract from their able and interesting report.

* A patent has been taken out in this country for destroying bugs, &c., by means of steam.—EDITOR.

"1. We had the honourable company's steamer Irrawaddy, moored alongside the Investigator; and having fitted two lead pipes into the Investigator, put them down the fore and after hatchways into the hold.

"2. We had, in the mean time, closed the scuttles of the Investigator's sides, as well as the hatches; moreover, the stern and gallery windows, and the entire front of the poop; boring, at the same time, a hole in each gallery cell, to allow the steam to come up fron the hold into the cuddy.

"3. We also fitted a pipe, having a stop-cock on it, to the main hatchway; which was opened occasionally, to observe the state of the steam, in case of danger from its over-pressure.

"4. These preparations being made, we had the fires of the Irrawaddy's boiler lighted at eleven A. M., on the 7th ultimo, so as to let on the steam at noon the same day; by six o'clock the same evening, the steam began to show itself at the scuttles, and at the hatches; and the poop and upper deck began to feel hot. We continued the steaming for forty-eight hours, by which time the whole of the decks and sides, even to the outside copper, close to the water's edge, was so heated, as to be scarcely touchable by the hand.

"5, On opening the hatches, to ascertain the result of the operation, we were pleased to see the effectual manner in which the penetrating effect of the steam had destroyed the vermin. The white ants appeared reduced to a substance like soap; and the cock-roaches and rats to a soft pulp, capable of being washed down into the limbers.

"6. The putrid smell of animal decomposition came on at the end of twenty-four hours, but did not continue above a day.

"7. The paint on the beams and sides was shrivelled, and peeled off; and the leather which covered the ring bolts in the cuddy, was converted into charcoal.

"8. We have purposely delayed sending in our report, till we could ascertain the effect of the steaming on the

caulking, a matter regarding which we were anxious, inasmuch as, if that had been disturbed, the operation would, in future, have had to be confined to a ship about to undergo repair in dock. We have, however, satisfaction in being able to report, that we can discover no injurious effect on the caulking; further, that the steaming a ship for the destruction of vermin, seems perfectly feasible, either afloat or in dock; whether about to undergo repair, or to proceed to sea. The only circumstance demanding attention in the latter case, is, that the ship will require new painting.

"9. Although the destruction of vermin by steaming, may be resorted to under all circumstances, yet the steaming of vessels in dock, previous to their undergoing their usual quinquennial repair of caulking and coppering, will be the most desirable.

"10. In addition to the advantages already noticed, the facility of introducing the steam from below; and the absence of condensation by the water in contact with the whole surface of the immersed bottom, when afloat, will enable the steam to effect its object in one-third less time.

"11. The present experiment having enabled us to ascertain an efficient and simple method of steaming ships, to destroy vermin; we beg here to record our opinion, that, in all moderately large ships, about to be steamed, the masts and bowsprit ought to be taken out, as also all projecting boomkins, davits, and cat-heads. The whole of the hammock stantions, and external birthing, should also be taken away; and the ship be cleared of all lumber, and articles likely to sustain injury from the steam.

"12. For large ships, where the unmasting would be laborious, we conceive that long bags, made of painted canvass, might be put over the mast heads, and be nailed to the deck; and the steam be then admitted into the bags. Painted canvass also might be tacked with wooden battens to the deck, and to the outside, enclosing the sides all round; and this might be extended to hawse-chocks,

quarter-galleries, and to all parts which it would be inconvenient to remove.

"13. By lifting the ship's pumps about three feet, one of them may be fitted as a steam-valve, and the other as a safety air-valve, and thus a communication be made quickly with the lower part of the hold. The steam pipes should be long enough to introduce the steam into the bottom of the hold; as, otherwise, the steam and heat would be, for a long time, intercepted from reaching the lower parts of the vessel, by a stratum of air.

"14. Such of the steamers as may be intended to be used for steaming ships, might conveniently, and at a small expense, be provided with a spare boiler, man-hole cover.

"15. The whole apparatus for steaming could easily be transferred to any one of the steamers, and would then be available for any ship. Independently of the man-hole cover, the parts would merely consist of two pipes of copper, fitted with stop-cocks, of five inches in diameter; together with a steam safety-valve pipe, for the ship about to undergo the process*.

"16. In steaming ships afloat, it will obviously occur to hang the steamer on to the vessel to be steamed; and then so to secure the two, as to prevent the cross motion, their being separately moored would cause, to the injury of the steam pipes. For steaming ships in dock, it will be requisite to have a boiler set so near to the dock, as to admit of having pipes fitted, for the conveyance of the steam to the ship.

"17. It will be requisite, when the steam has been admitted into a ship, whether it be afloat or in dock, to have a cauldron of boiling water ready, to kill those insects which may attempt to escape; and it will also be requisite to have a few persons in attendance, to shut up those places where the steam shows itself; as well as to attend to the state of the pipes, and of their operation.

* Partial condensation, such as in the case of the Investigator led to the fracture of the upper deck pillars, would, by these valves, be effectually guarded against

"18. We come now to the consideration of the vast importance to shipping in tropical climates, which this successful experiment of steaming ships to destroy white ants has indicated. The speedy riddance of rats, cock-roaches, centipedes, and scorpions, would alone be of importance. The waste of property by the two first, is very considerable, and fumigation is frequently employed to get rid of them; smoking is dangerous, inasmuch as many ships have been burned in the process; but although smoking kills rats, it will not kill cock-roaches nor ants; neither has it the slightest destructive effect on their eggs; so that while the larger tribe of noxious vermin may be got rid of by this means, the smaller and much more dangerous ones, the white ants, are left to destroy the ship.

"19. Sinking is, no doubt, an effectual measure for the extirpation of those insects; but it is one which can only be resorted to in small ships, and in them even at a considerable risk of entire loss, and at a considerable expence; a great waste of time in the employment of the vessel, and the disadvantage of laying a foundation, by the introduction of mud, for a future more successful attack. In fact, it has invariably been found, that vessels which had been sunk to kill the white ants, were speedily infested afterwards, and rapidly destroyed!

"20. The being enabled to eradicate the white ants from Indian ships, must have the effect of giving an enhanced value to this description of property. It is on record, as well as a truth familiar to the officers of the Marine Department, that several government vessels have been entirely destroyed by the white ants; and further, that by their ravages, great public loss has been sustained; under such circumstances, too much cannot be said in favour of such an application of steam.

"21. The success of the recent experiment may form an era in the history of Indian shipping. The steaming of vessels, to destroy vermin, must speedily come into general use. Then the only wonder will be, that seeing the

common application of steam to almost every purpose, its excellence, as a substitute for fumigation, was not, in this country, sooner suggested."

It is scarcely necessary to add a word to the above clear detail. The expence of the operation, including the requisite pipes, &c., did not amount to eight hundred sicca rupees; and the subsequent charge for cleaning the ship, was about one hundred. A complete apparatus, to be attached to the boiler, it appears, would not cost above fifteen hundred sicca rupees; after which, the expence would be confined to the expenditure of coals, and the necessary artificers, and contingent charges. One precaution, however, would appear to be necessary to be adopted in the steam-vessel, which is, to take care that none of the vermin find their way from the vessel steamed to the steamer. Such appears to have been the case with the Irrawaddy.

Remarks. By the EDITOR.

We think that, in many cases, in tropical countries, this excellent method may be applied, with great success, to the destruction of the white ants, in buildings on shore, where they commit such infinite mischief. A portable steam-boiler might be readily conveyed from one building to another, as occasion required.

XXII.—*On making Plaster Casts from Medals. By Mr.* W. KELSALL, *Engraver,* 8, *Clarendon Street, Somers Town* *.

THE substance most commonly used for forming moulds from medals, and other small works of art, are sulphur, plaster of Paris, and wax. The first of these is, perhaps, in most general use, from the ease with which the mould is made. It is, however, objectionable, as it injures the medal; and, besides, seldom brings the work up with a

* From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, Adelphi.

sharp edge, occasioned by the oil used on the surface of the medal to prevent adhesion; it may also, in some measure, be caused by the cooling of the sulphur, before it has an opportunity to run into the finer parts of the work. As it is necessary to oil the mould before a cast can be taken from it, so it is very rare that a good one can be procured. Plaster of Paris, though very useful for forming the moulds in large castings, is, according to the usual practice of oiling*, still more unfit than sulphur for small subjects, as it requires to be thoroughly saturated with oil, and then it is by no means certain that the cast will not stick to the mould. The only way of using it to advantage is, by dipping it, when thoroughly dry, into melted wax, and allowing it to be fully saturated with it; then to take it out, and when it has become cold, it is fit for casting from, requiring only to have a thin wash of wax, dissolved in spirit of turpentine, applied over it instead of oil, before casting in it. This should be allowed to become dry, which it generally does in about fifteen minutes, and it will then bear the wet mixture of plaster and water, to be driven into the finer parts of it with a camel's hair pencil (a very necessary operation in medal casting, to expel the air, which otherwise lodges in the deeper parts of the mould, and causes imperfections in the casts). When this method is properly attended to, the cast leaves the mould easily, and is nearly as good as one taken from a mould of wax.

Wax forms a perfect mould, if the operator has the skill to manage it properly. It is, without doubt, the most difficult to procure a good mould with; but when once obtained, it lasts, and is cast from without trouble. The following is the best method to have it good: fasten a ledge or border round the medal, and which may be made either of paper, pasteboard, or, which is better, of the thin lead which lines tea chests, the strip should be about three quarters of an inch wide, and it should be carefully tied or bound close

* See a substitute for oil, in the Additions to this Article, by the EDITOR.

around the rim of the medal; or, otherwise, the melted wax will find its way out, when poured upon it. The wax should be melted in a cup, placed in boiling water, as that keeps the heat regular, and gives the wax a proper degree of fluidity. The surface of the medal should be quite clean, neither oiling it, nor any other application being required. Warm the medal slightly (the blood-heat is sufficient), to prevent the wax from chilling as it is poured in, then pour in the wax as quickly as possible. As it cools, pass the blade of a thin knife horizontally all around the top of the wax which has been attracted to, or flowed up at the border, and level its surface, as, otherwise, from its increased thickness there, it would be likely to crack the wax through in a ring, all the way round. When the wax is become perfectly cold, strip off the edge or border; and, if the mould does not then separate easily from the medal, place a fire-shovel over the fire, and let it become hot; then place the medal upon it, with a piece of paper laid beneath it, to prevent rubbing it; and try, every four or five seconds, what degree of heat it has acquired, by bringing it into contact with the face. When the medal thus feels slightly warm, try to separate it, and, if it will not part from the wax, warm it till it does. Great care is necessary to be taken in this part of the process, or, otherwise, the mould may melt, and thus be spoiled. But, if well managed, it frequently saves many moulds which would otherwise be lost.

To cast from a wax mould, it requires only to be surrounded with a rim or border, and the mixture of plaster and water may then be poured into it, taking care to drive the plaster well into the deeper parts of the mould, with a camel's hair pencil.

In mixing the plaster, the quantity of it is always regulated by that of the water; if mixed in a bason, keep adding the plaster in a conical heap, until its apex reaches above the surface of the water; then stir the mixture, and not before; and it will always be of the proper degree of thick-

ness. It should then be instantly poured into the mould, and remain until it is properly set, which it will usually be in about fifteen minutes, no attempt to separate it ought to be made in a less time.

Additions. By the EDITOR.

Many years since, the Editor possessed himself of improvements in the art of forming plaster casts from medals, and other delicate works of art, made by the late Mr. John Francillon, an eminent jeweller in this metropolis, and who was possessed of an invaluable rosary, formed of nectarine stones, and carved by the celebrated Florentine artist, *Benvenuto Cellini.* Each of these stones had either the head of a Roman Emperor, or of a Pope, most exquisitely carved upon one side of it, and upon its other side, either a triumphal arch, a public building, or some other subject, similar to the reverses of medals. Mr. Francillon, was in the practice of making casts in plaster of Paris from this series for his friends, and had formed a set of sulphur moulds therefrom with this view. In order to form these moulds, he encircled each model with a rim or border, of paper, latten brass, or pasteboard oiled; and then poured in sulphur (which had been previously heated, until it became thick like treacle, which gives it a brown colour, and prevents it from cracking, and had then been suffered to cool until it had become thinner, when it was instantly poured into the rim or border); when cold, the sulphur might be removed, and then formed an exact mould of the original. When he wished to take casts in plaster from these moulds, he either previously wiped a mixture of oil and rum, or of rum only, over them; and then having previously surrounded them with a rim or border, he made a mixture of fine and new plaster of Paris, mixed with raw terra de Sienna, to take off the great whiteness of the plaster, and thin gum-water; a little of this was poured into the mould, in a thin state, and strongly blown upon, in order to make it fill the hollows, and drive out all the air-

bubbles; he then poured upon it, on one side, the thicker plaster, and let it run gently to the other side, driving the air out before it. When this had become hard, he removed the rim of card, and substituted another of a slip of leather or pasteboard, which had been previously gilt upon its edge, and was coiled two or three times around the cast, and then cemented firmly to it.

XXIII.—*On Chinese Unburnt Bricks.* *By* Henry H. Goodhall, *Esq.*

SIR, *No. 55, Crutched Friars, January 2, 1830.*

After perusing the article in your *Technological Repository*, on the subject of unburnt bricks, I thought it might be pleasing to you to know, that many specimens of such bricks, from so remote a country as China, are to be met with in London. I send you one herewith as a specimen, and others, of various dimensions, you are welcome to see, if you will favour me with a call.

The fragment sent, we have generally considered as part of a tile, but from many other pieces being sooty, they probably formed part of a small flue or chimney.

The whole of these bricks and tiles have come from China, as substitutes for their weight of tea, plundered from the chests in which they were found, and, most probably, the roguery took place at Canton, as they have only appeared in this country since the great fire at that place, a few years back.

I am, sir,
Your obedient servant,
H. H. Goodhall.

To T. Gill, Esq.

Remarks. *By the* Editor.

The brick or tile sent us by Mr. Goodhall, is an inch and a quarter thick, five inches broad, and eleven inches long, it is coloured red on the outside, and has Chinese paper pasted upon it. Internally, however, it is of bluish grey colour, and is evidently unburnt.

We understand that the above mentioned fraud has now become so extensive, as to have excited the particular attention of the East India Company, with a view to prevent it in future.

XXIV.—*On various Improved Pastes and Lutes. By the* Editor.

Bookbinder's Paste, of Wheaten-Flour and Alum.—The bookbinders are in the habit of making a considerable quantity of paste at once, and it takes a long time to incorporate the wheaten flour and the water together, in the usual manner of doing it; Mr. W. H. Kelly, our book-binder, has, however, greatly shortened this time, by adopting the following improved method. He first mixes the flour with cold water, to the consistence of thick batter; then, having a measured quantity of water boiling-hot, in a tea-kettle, in which a proper quantity of alum had been dissolved, by puting it into the water cold, and boiling it, he adds a little of this boiling alum-water, by degrees, to the batter, stirring it well in, till he sees the effect it has produced on the flour, by a change in its appearance, when he suddenly pours the remainder of the boiling water into it, and also stirs it well all the while. In this way he soon makes the whole into paste; whereas, on the old plan of mixing it with cold water, and then boiling it; it occupied a whole day in breaking down the lumps which formed in it.

Lute, or Paste, of Albumen and Wheaten Flour.—The Editor lately found an ingenious copper-smith fitting together the inside joints of a distilling apparatus, by putting between the shoulders of them, stout hempen cloths, coated on both sides, with a thick mixture of wheaten flour and the whites of eggs (albumen), made in the cold. In this judicious way, and without tainting the flavour of the alcoholic liquors, to be distilled in the apparatus, he employed a lute, which, instead of dissolving in the hot vapours, on the contrary was hardened by them. He em-

ployed a thick mixture of white lead ground in oil, to coat the exterior of his joints as usual.

The late Mr. Samuel Varley's Chemical Lute.—This consisted of wheaten-flour, mixed with cold water, to which he added a portion of common salt. On applying a little of this lute, either to close the joints, or to stop the issue of vapours in distilling, the heat instantly acting upon the flour, changed it into a thickened paste, which had the desired effect. As, however, it might have been difficult to unlute the apparatus, after the operation was finished, so the salt was added to the lute, by way of introducing water into it, to soften it.

Paste of Wheaten-Flour and Resin.—A German manufacturer of ladies' work-boxes, jeweller's trays, &c., was in the habit of lining them with morocco leather, velvet, or paper, with a paste composed of wheaten-flour mixed up with water, and boiled; and whilst boiling, he incorporated a quantity of black resin with it, which greatly improved its strength, and prevented it from being so easily affected by moisture. He finished it by straining it through a coarse cloth, and thus removed all the lumps in it.

Paste of Wheaten-Flour and Wax.—A Mr. Mayhew informed the Editor of this improved paste, many years since; and which he made in the following manner. After boiling a mixture of wheaten-flour in water, to form a paste as usual, he stirred a piece of wax candle round in it a few times, and which, mingling with the paste, greatly improved its binding quality. The Editor made some of it, and found it to have acquired a saccharine taste, from the union of the wax with the flour.

Paste of Bean-Meal.—Mr. Boyle Godfrey, in a chemical work published by him many years since, says, that a paste composed of bean-meal and water, may be usefully employed in closing letters, and that such closures cannot possibly be loossened by directing the steam of boiling water upon them, as would be the case when the ordinary wafers were so treated.

Clay's Paste, of Wheaten-Flour and Gelatine.—The paste by which the sheets of whited brown-paper were so firmly held together, in the celebrated Clay's, of Birmingham japanned paper tea-trays, &c., was a composition of wheaten-flour and carpenter's glue boiled together. Each sheet of paper was united singly to the others by this paste, the air being carefully driven out from between them by wiping with a coarse cloth from the centre towards the sides; and they were besides carefully dried in stoves, between each layer. Thus combined, they might be sawn, planed, nailed, and glued together, in the manner of wood; but the articles were much lighter and stronger, when japanned, than if formed of wood.

XXV.—*On an improved Method of making Raisin Wine. By* Arthur Aikin, *Esq., Secretary to the Society for the Encouragement of Arts, Manufactures, and Commerce, Adelphi, F.L.S. F.G.S. &c.**

I have for some years been in the habit of making for use in my own family, a light dry raisin wine; I have also noted down, with more or less minuteness, the progress and result of several of these experiments; and I beg leave now to offer them to the Society, in the hope that thereby some additional light may be thrown on a very important branch of domestic economy.

It appeared to me, from some previous comparative trials with black currants, and with others of our native fruits, that none of them are so well adapted to make light dry wines, as the better kinds of raisins: a farther advantage attends the use of this latter fruit, that the wine may be made at the season when the temperature is most favourable to the due progress of fermentation.

The raison which I have been most in the habit of using, and which I prefer, is the Muscatel. It is imported in boxes, containing about twenty pounds; and, when new,

* From the Society's Transactions, just published.

is in common use as a table fruit. In this state it would doubtless make a wine of excellent quality; but its price prohibits its employment for this purpose. In those which remain unsold for about a year, the rich pulp of the recent raisin, becomes mixed with sugary concretions, which render it less acceptable at the desert; and the price of such fruit, being from ten pence to a shilling a pound, brings it within the reach of the domestic wine-maker.

That matter, whatever it be, which, through the process of fermentation, converts a solution of sugar into vinous liquor, exists in raisins in sufficient abundance to change into wine a greater quantity of sugar than the fruit itself contains; and I have found it advantageous, both as regards the price and quality of the product, to add to any given quantity of raisins from one-tenth to one-third of their weight of sugar. In order, however, to avoid tainting the wine with the peculiar flavour of cane-sugar, I use good loaf, at the average price of ten pence or eleven pence a pound.

In my early experiments, I poured hot water on the raisins, and allowed them to remain therein twelve hours, more or less; by this time the raisins were plumped up, and I pressed them between fluted wooden rollers, in order to break their skins, and press out the juice. This process, however, by no means succeeded to my wish; the rollers were clogged and strained by the fruit which adhered to them; and many of the raisins, by reason of the toughness of their skins, passed though the rollers entire. I therefore adopted the plan of having the raisins chopped (without previous maceration) on the same kind of tray, and with the same kind of chopper, as is used in making minced meat; and I have had no reason to vary from this method, except that, of late, I have directed the raisins to be chopped finer than they were at first. Previous to the raisins being chopped, the stalks are separated for a use that will be mentioned hereafter.

I have tried several proportions of ingredients, but those

from which I have obtained the best results, are three pounds of raisins, and one pound of sugar, to an ale gallon of water.

I prepare the must, sometimes by mashing, sometimes by maceration.

The mashing is performed in the following manner: the chopped raisins being put into an open tub, or an earthenware pan, I pour on them hot water, in the proportion of about a quart to four pounds of fruit. My object, in this first mash, is to extract the greater part of the saccharine mucilage, as little altered as possible; I therefore heat the water no higher than about one hundred and twenty degrees of Fahrenheit's thermometer; the water and fruit are mixed, and after standing for about a quarter of an hour, the whole is stirred together as accurately as possible by hand, taking care to break down all the lumps; and, in a few minutes afterwards, is placed on a sieve over a tub, where it drains for a short time; the husks are then lightly pressed by hand, and are returned to the mash-tub.

The second mash is made exactly in the same manner as the first; and the husks, after pressing, are returned again to the mash-tub.

They will now be found to have lost the whole of their clamminess, though they are still sweet; I therefore conclude that the saccharine mucilage is now for the most part extracted, and my principal object in the subsequent mashes, is to dissolve out the tartar. For this purpose, the water of the third mash is put on at the heat of one hundred and fifty or one hundred and sixty degrees, and is conducted in the same manner as the former. The liquor thus obtained, is considerably acidulous, having the flavour of the raisins, and but little sweetness. Three-fourths of the mash being now made, it is tasted, in order to ascertain whether it is sufficiently astringent; and, according to the intended astringency of the wine, I either altogether reject the stalks, or use the whole or a part of them. If a somewhat astringent wine is intended, the last mash is thus pre-

pared: I pour boiling water on the stalks, in a separate tub, and after they have been macerated for about a quarter of an hour, I put the liquor on the husks, and mix them well with it; in a quarter of an hour more, the liquor is put on the sieve, and the husks are well squeezed by hand.

While the last mash is preparing, I transfer the liquor of the first three mashes into the fermenting tun, and dissolve the sugar in it; I then add as much of the last mash as is requisite to bring the must to the due proportions, viz., one ale-gallon of must, to three pounds of fruit, and one pound of sugar. The time occupied by the above processes is four or five hours, and the temperature of the must, when put into the fermenting tun, is usually about seventy degrees.

If the weather is warm, and apparently more likely to become hotter than colder, I pour the must into the fermenting tun with as little agitation as possible; but if it is cool, and not likely to get warmer, I dash each pailful against the sides of the tun, pouring it in from as great a height as I can conveniently reach; by this means, it is more mixed with atmospheric air; and liquor thus treated will often begin to ferment in less than twelve hours. If the must is at the temperature of seventy degrees, fermentation begins in from twelve to thirty-six hours, according as it is treated; and the scum which rises is sometimes taken off every day, and sometimes allowed to remain till the liquor is about to be removed from the fermenting tun. If the fermentation is languid, I keep on the cover of the tun, and stir the scum daily into the liquor; if too rapid, I take off the cover, and remove the scum as it rises.

The lowest temperature at which I have observed fermentation to take place, is forty-eight degrees. On this occasion, the must was at forty-eight degrees when it was put into the tun, the temperature of the cellar being forty-six degrees. On the next morning, it was at forty-seven degrees; and on the second morning, at forty-six degrees;

the temperature of the cellar remaining the same: on the third morning, both the liquor and cellar were at forty-five degrees, no signs of fermentation having yet appeared. The liquor was then placed before a fire for some hours, and fermentation began; it was then removed to the cellar, and on the fourth day, the fermentation was going on steadily but slowly, at forty-eight degrees. I have never made wine when the heat of the air was above seventy degrees; and, on the whole, I prefer a temperature of from fifty-five to sixty degrees. That of the liquor, after the second day, continues about two degrees above that of the cellar, till the eighth or ninth day, when the fermentation has usually become languid, and the heat of the liquor, and of the cellar, scarcely differ more than one degree.

The liquor is now vinous, but sweet; and, after carefully skimming it, I transfer it to glass carboys, containing about six or seven gallons, or to stoneware barrels, of the same size*. I insert in the bungs glass tubes of safety; and, on the second day, pour into them about an inch of quicksilver, to exclude the air. The cement that I use for covering the bungs, is a mixture of wax and resin.

Carbonic acid continues to bubble through the quicksilver in the safety tube for some weeks; after which, it ceases; but the column of quicksilver in the exterior leg of the syphon, is always higher than that in the interior leg. I have never seen a single instance of the outer air passing into the carboy.

The loss during the fermentation in the tun, is about six per cent.; subject, however, to variations from the temperature of the liquor, from the scum being removed once or oftener, and from the cover of the tun being left on or off.

I think the wine ought to remain an entire summer in the barrel or carboy, in order that the fermentation may proceed so far as almost entirely to decompose the sugar;

* As barrels of stoneware are always more or less porous, they should be warmed thoroughly before a fire, and be rubbed over with a mixture of bees' wax and turpentine (about one part of turpentine to three of bees' wax): when this coating is grown cold, it should be well rubbed in with a hard brush.

and as my usual times of wine making are April and October, that made in the former month is bottled in the March following; and that made in October, is bottled about the end of September, or a week or two later, according to circumstances.

I never fine the wine, being of opinion that the light dry wine, which it is my aim to produce, would be materially injured by being deprived of its tannin, through the action of isinglass, or of any similar substance.

At the time of bottling, I have seldom observed the wine to have any very sensible flaxour,—meaning by flavour, that compound sensation of smell and taste, which characterises the finer kinds of wines; but after remaining for a year in bottle, a flavour resembling elder flowers is strongly developed, mingled, generally, in a slight degree, with that of prussic acid.

As soon as the wine begins to run turbid from the carboy, I pass the whole of what remains through a filter; but though I am careful that the wine, when bottled, should be clear, though not bright, there is always more or less of flocculent matter deposited, which requires the bottles to be set upright in the bin, and to be decanted with care.

The wine, when first decanted, is often of a very pale yellow colour, especially if high flavoured; but in an hour or two it deepens more or less, and at length acquires a tint like that of Bucellas, the prussic acid flavour at the same time disappearing.

Instead of mashing, as above described, I have sometimes pursued a still more simple way,—that of maceration; by mixing in the fermenting tun the usual proportions of chopped raisins and sugar with cold water, and leaving the raisings in the liquor during the whole of the first fermentation. By this method I obtain a higher-coloured wine; but, the fermentation being generally slower, and consequently longer, it is destitute of that Frontignac, or elder-flower, flavour, which it generally acquires when treated according to the first process; and is apt to get a less

agreeable flavour from the husks of the raisins. Sometimes, however, the method succeeds very well; and the elder-flower flavour not being pleasant to many persons, such wine is more generally acceptable than the former.

In May, 1827, I made some wine in the way last described. The materials were put together on the 3rd day of the month, the temperature of the liquor and of the cellar being fifty-six degrees. On the 5th, at night, fermentation had just began, the temperature of the liquor and cellar being fifty-seven degrees. On the 7th, the liquor was at fifty-eight degrees. From that time to the 19th, the fermentation went on, though languidly, the temperature of the liquor varying from fifty-seven to fifty-eight and a half degrees; and that of the cellar from fifty-five to fifty-seven degrees. From the 19th to the 24th, the weather became warm, the temperature of the cellar rose to fifty-nine degrees, and that of the liquor to sixty-one degrees. It had now been twenty-one days under fermentation; and therefore, though it was still rather too sweet, I put it into carboys, and bottled it about half a year afterwards. This wine is now (December, 1828) strong, dark-coloured, for white wine, but still rather sweet, and tastes too much of the husks.

XXVI.—*On the Importance of Improving the Art of Ship-Building* *.

In no period of the world, has the subject of naval architecture had higher claims on public attention than the present, and to our own country in particular, it is an art of such transcendant importance, that no means should be left untried. Nor is it only in a commercial point of view, that ship-building is valuable to man, since, by the enterprise that fortunately characterizes the modern navigator, the ocean is become one of the high roads of civilization, perhaps

* Abridged from a notice on the Article Ship-building; published in vol. XVIII. part I, of the *Edinburgh Encyclopædia*. Edited by Dr. Brewster.

the highest; and, therefore, in the successful cultivation of the various arts connected with navigation and commerce, every lover of human improvement must feel an interest, proportionate to the influence which they are now universally allowed to exercise on the improving destiny of man.

Naval architecture may be contemplated under three points of view. First, as regards the means it affords for the purposes of war; secondly, as it relates to commercial enterprise and speculation; and, thirdly, as it is connected with human improvement, the enlargement of geographical knowledge, and the extension of the blessings of civilization. The cultivation of the first is unfortunately rendered necessary by the peculiar condition of the world, and perhaps the second and third are in some degree assisted by it; but it is the successful advancement of the latter that renders the study of naval architecture most pleasing, and elevates it to rank with those arts which minister so essentially to the happiness and well being of man.

The author of the article under consideration has contemplated his subject in the most general points of view. Omitting the early history of the art, the materials for which are abundantly supplied by Charnock and others, he advances at once to its leading and essential elements, and connects, in a comprehensive form, the labours of Bouguer and Euler, with those of Atwood, Chapman, and Seppings. Ship-building, though an imperfect art, has many great and celebrated names connected with its history. Assuming, for the first time, in the latter part of the seventeeth century, a scientific form, in consequence of the labours of Paul Haste, in his *Theorie de la Construction des Vaisseaux*, we find it afterwards enriched by the labours of many mathematicians; and the masterly improvements of Seppings in our own times, has added to it a perfection it never before possessed. The creation of the College of Naval Architecture, in Portsmouth Dock-Yard, has also communicated to it a great impulse. It cannot now be said, to adopt the language of the author, when

speaking of its former condition, that the torch of geometry does not illuminate its path, or that the maxims of mechanical science are not applied to its daily practice. Inquiry has been awakened, and the antiquated rules, which formerly guided our ship-builders, are now gradually giving way to methods, authorized by the legitimate deductions of science. It is a mighty and comprehensive problem, to contemplate all the essential elements connected with the construction of so massive and stupendous a fabric as a ship, destined for all the terrible purposes of war, which, in the magnificent voyages it undertakes, has to cross wide and immeasurable seas, agitated at times by the unbridled fury of the wind, subjecting it to strains of the most formidable kind; which shall possess mechanical strength to resist these, and at the same time be adapted for stowage and velocity, which is expected in all cases to overtake the enemy, and yet must contain within it the *materiel* for a six month's cruize. These, and many other complicated inquiries, which the naval architect has to contemplate, must all be involved in the general conditions of his problem, the elements of which he must estimate, while he is rearing his mighty fabric in the dock, and be prepared to anticipate their effects, when he launches his vessel on the turbulent bosom of the sea. And yet there are men, blind to the experience of the past, who deny that science has any thing to do with the construction of a ship. Science, says the eloquent author of the article, is the basis of every well ordered machine. Science was the ground work of all that Watt, Smeaton, or Wren ever achieved; and can science, says he, be unnecessary in the formation of a ship? We must say in reply, that science is absolutely necessary in the construction of a ship, and we cordially agree with the writer, that the college of naval architecture is likely to prove a most beneficial institution to the country. In the year 1795, we find that the commissioners appointed to revise the civil affairs of the navy, remarked, that the class of persons from whom the master ship-wrights and sur-

veyors of the navy were chosen, " had no opportunity of acquiring even the common education given to men in their rank of life, and that they rise to the complete direction of the construction of ships, on which the safety of the empire depends, without any care or provision being taken on the part of the public that they should have any instruction in mathematics, mechanics, or in the science or theory of ship-building." The death blow to this lamentably imperfect system was, however, given by the establishment of the college.

Our author has given a forcible outline of the course of studies pursued at this admirable institution. After a severe contest before admission, the successful candidates remain seven years at the college, pursuing geometry, algebra, trigonometry, in all their important applications, examining the theoretical and practical details of mechanics and hydrostatics, and closing their purely mathematical inquiries by an enlarged course on the differential and integral calculus. After obtaining sufficient elementary knowledge, they are employed in constructing original designs of ships of war, ascertaining their displacements, and of the whole masses of the ships and their equipments, considered as heterogenous bodies. To this is added the most exact and accurate inquiries connected with the stability, both according to the metacentric method of Bouguer, and to the more perfect and precise investigation of Atwood. Comparisons are also instituted, the quality of English ships are compared with those of a foreign build, their several properties are analyzed, the good qualities are combined so as to remedy the bad, and to produce in their ultimate application the most perfect design.

But it is not to theory only, that their attention is directed. The practical details of the art receive a large portion of their attention. They are effectually taught how to lay off ships in their practical construction, and in making drawings which are necessary for the execution of the work, in the progress of the building. The adze and

the line are put into their hands, like the humble operative at the dock-side, and a vigilant practical ship-wright examines into the minutest details of their duty. Engaged, therefore, in the morning, we will suppose, in studying the theory of their profession, in calculating the displacement, in investigating the properties, of the midship section, or endeavouring to catch a glimpse of the deep and recondite laws that regulate the resistance of fluids, they turn in the afternoon to the practical details of their art, in shaping or adjusting timbers, fitting up the component parts of the seppings' diagonal framing, bolting together the timbers of his circular sterns, and observing in those numerous cases, which the eye of theoretic intelligence is in general so ready to catch, the actual application of rules which occupied their morning thoughts. What else, our author asks, is necessary to make a complete and perfect ship-wright? The members of the college have the amplest and best theories continually before them, and the most enlarged practice to exemplify their application.

Our author, however, closes this part of his paper with an admonition, which will not, we hope, be neglected in the proper quarter. The studies of the members of the college, says he, are but begun, when the term which marks their residence has expired. Naval aachitecture is a jealous mistress, and requires the undivided man. Not the devotion of a few years, but of a life consecrated to its pursuits with unwearied zeal, must be devoted to its interests; and the cordial and uninterrupted pursuit of its varied details, must meet with the reward which attends the industrious labourer in other departments of the art.

We are glad to find, however, that our author, notwithstanding his able and vigorous defence of the college, has not neglected to consider the condition of the working men. Among the many operatives which a dock-yard presents, says he, there must be some few, at least, deserving of a better fate, than to spend the long term of their lives in a perpetual state of unceasing labour; some, though

working at first as humble shipwrights, yet deserving from their talents to rise to command. The great object, says the author, in a well regulated community, is to encourage ability, wherever it appears; and we are persuaded that the welfare of the country will be essentially promoted by fostering native talent."

"The section on the dimensions and forms of ships, is one replete with the most interesting inquiries. The gradual augmentation that our ships of war have received in their dimensions, is connected with the most interesting and important principles. A first-rate, constructed a century ago, is a vessel of quite a different class from a first-rate of the present day. Of such magnificent ships as the Britannia, the Prince Regent, or the St. George, our forefathers could have no conception. They are not only magnificent as exhibiting the mightiest combination of timbers ever constructed by man, but in future wars will develope energies more terrific than any exhibited at St. Vincent or Trafalgar. The Regent, of 1000 tons, constructed in the reign of Henry the Seventh, can bear no possible comparison to the Regent, of 2600 tons, constructed in the reign of George the Fourth! Spain was the first nation that increased considerably the dimensions of her different classes of ships, and France followed her example with better success. In later times, the Americans have made some great steps in this important inquiry; and we rejoice to find that our own excellent naval administration have not lost sight of the subject. There are many advantages resulting from the enlargement of the dimensions of ships. It enables them to possess great stability, and thereby to carry a great press of sail with a comparatively small body immersed in the water; thus giving them a great moving power, in proportion to the resistance they experience, and thereby increasing their rate of sailing. Large dimensions also, in proportion to the nnmber of guns, gives fine quarters to the men in action. It enables a finer form to be given to ships below the water, so that they have a good

entrance forward, and a clean run aft to the rudder, and to have the form best calculated to present great lateral reristance to the water, which prevents the ship from making much lee-way.

The only objection to this increase of dimension, is the expense; and possibly there are some limits beyond which it cannot be carried. We are persuaded, however, that this limit has not yet been attained, and we earnestly press its consideration on our naval engineers."

XXVII.—*On Parabolical Cupped Patent Breeches, for Gun-Barrels. By the* Editor.

It is now thirty years since the Editor, at the suggestion of a scientific mechanic, first applied the parabola to shape the cups of patent breeches for gun-barrels, instead of the spherical form generally given to them, and the effect of which spherical form, was to cause the shot propelled therefrom by the charge, to be continually reflected to and from the sides of the barrel, during its whole passage through it, to the great injury of its effect. Whereas, it is a known property of the parabola, to cause any body propelled from its surface, to proceed in direct parallel lines, without any crossing, as in the case of the spherical cups. This parabolical shape likewise affords great facility and convenience in cleaning the cups, after the day's shooting; whereas the spherical cups are very difficult to clean. The Editor recommended this parabolical form of the cups to his friend Mr. Samuel Nock, a respectable gun-maker in this metropolis, twelve years ago; who immediately saw the great advantages of it, and has constantly adopted it ever since. He, however, has lately complained to the Editor, that another London gun-maker is now advertizing the parabolical cupped breeches as a new discovery; and it is therefore but fair to state the above particulars of the original application thereof by the Editor, thirty years ago; and its adoption, twelve years since, by Mr. Nock.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since January 12, 1830.

To William Hale, of Colchester, in the county of Essex, machinist; for a machine or method of raising or forcing water, for propelling vessels. Dated January 12, 1830.—To be specified in six months.

To James Carpenter, of Willenhall, in the parish of Wolverhampton, in the county of Stafford; and John Young, of Wolverhampton, aforesaid, locksmiths; for certain improvements in locks, and other securities, applicable to doors, and other purposes. Dated January 18, 1830.—In six months.

To William Parr, of Union-place, City road, in the county of Middlesex; for a new method of producing a reciprocating action by means of rotary motion, to be applied to the working of all kinds of pumps, mangles, and all other machinery, in or to which reciprocating action is required or may be applied. Dated January 18, 1830.—In four months.

To Edward Dakeyne, and James Dakeyne, both of Darley Dale, in the county of Derby, merchants; for a machine, or hydraulic engine, for applying the power or pressure of water, steam, and other elastic fluids, to the purpose of working machinery, and other uses requiring power, and which is also applicable to raising or forcing of fluids. Dated January 21, 1830.—In six months.

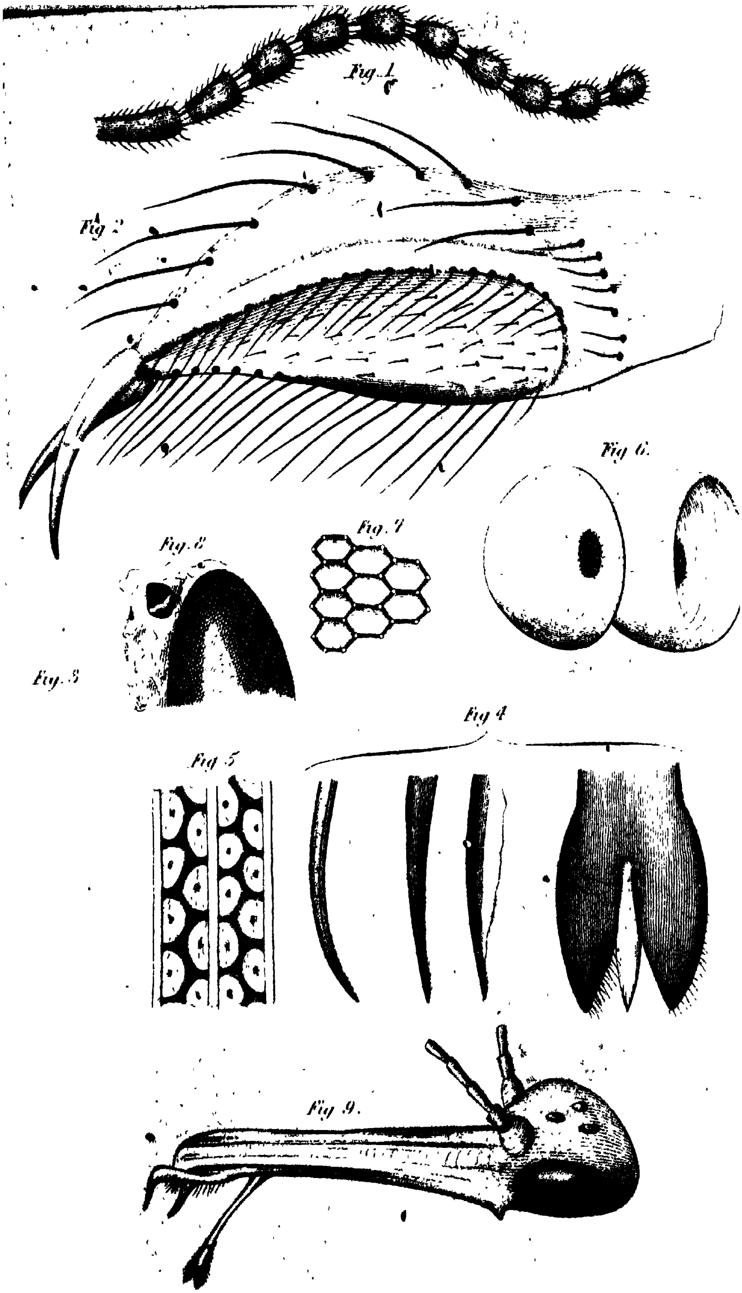

Fig. 1
Fig. 2
Fig. 6.
Fig. 7
Fig. 8
Fig. 3
Fig. 4
Fig. 5
Fig. 9.

GILL'S
TECHNOLOGICAL & MICROSCOPIC
REPOSITORY.

XXVIII.—*On the Microscope. By* THOMAS CARPENTER, *Esq. With Remarks and Additions. By the* EDITOR.

WITH FIGURES.

(*Continued from page 78.*)

DEAR SIR, *London, February* 8, 1830.

THE beginning of last June I met with a cluster of eggs, attached to the leaf of a water-plant; they were disposed with so much symmetry, that I took them home to examine under my microscope, and found I had procured a very interesting object. I believed that they had been placed on the plant by one of the water-beetles; and wishing to ascertain the species, I placed that portion of the leaf to which they were agglutinated, on a small piece of cork, and which I floated on the surface of some water, placed within a tea-cup. In a few days the larvæ had left the eggs, and had crawled down the sides of the cork into the water: there were hundreds of them, and so exceedingly minute, that I could make out nothing without placing them under the object-glass of my microscope. I then found them to be the larvæ of a species of dyticus, and more interesting microscopic objects I have scarce ever met with. They were furnished with forceps or jaws at their heads similar to the *dyticus marginalis*. The minuteness of these larvæ rendered them fine microscopic objects, as they would bear a very high magnifying power, under which their internal structure was plainly seen.

I have also met with clusters of similar eggs attached to the blades of grass, growing on the banks of the New River; and, by using the above method, have succeeded in producing larvæ from them, with precisely the same characters as those from the eggs found on the water-plants in ponds. I herewith send for your inspection the empty shells from which the above insects had come out; and also some perfect eggs, which I had dried, by heating them, in order to prevent the larvæ from coming forth. The characters on the external parts of these eggs you will find very curious; indeed, the eggs of all the insect tribes are highly interesting objects; the various shapes and markings upon them, are almost as diversified as the insects themselves. They are to be met with of various colours, some are found of almost every shade of yellow, green, and brown; a few are red, and others black. Green and greenish coloured eggs are not unusual; and they are sometimes speckled over with darker colours, like those of birds. Some are smooth, and others beset, in a pleasing manner, with raised spots. We are accustomed to see the eggs of different species of oviparous animals so nearly resembling each other in form, that the very term egg-shaped has been appropriated to this particular figure. Among those of birds, with which we are most familiar, the sole variations are merely shades of difference between a globular and an oval or ovate figure. The shapes of the eggs of insects, however, are confined to no such limited model. They differ often as much, both as to their shape, markings, and appendages, as one seed does from another. Their usual forms indeed are globular, oval, or oblong, with various intermediate modifications. We meet with them shaped like the common hen's egg; flat, and orbicular; elliptical, conical, cylindrical, hemispherical, lenticular, pyramidal, square, turban-shaped, pear-shaped, melon-shaped, boat-shaped, of the shape of a drum, &c.; and sometimes of shapes so strange and peculiar, that we can scarcely allow their claim to the name of eggs! In

Kirby and Spence's excellent work on Entomology, plate XX., you will meet with a great variety, both in their shapes and markings, of the eggs of insects, of the accuracy of which there is no question; and, indeed, you may satisfy yourself thereon, by seeking for varieties of insect's eggs during their proper season. In the mean time, I send a few specimens from my collection, for your examination. Some of these are from the vapourer moth, and are curiously embedded in hair. The female moth is destitute of wings, and therefore cannot fly. The males are very shy, and difficult to capture. The method of taking them is very singular: a collector, having a female moth confined within a pill-box in his pocket, has only to go into the woods, and the males, by some powerful instinctive faculty, will find them out in that secluded situation, and, hovering over the collector, they are easily taken in his net. Mr. Stone, a celebrated entomologist, assured me that he has had females confined within a breeding cage in his yard in London, and the males have even found their way from the woods, over the houses, and alighted on the cage in which the females were confined! I have before remarked, that Mr. Samouelle stated that the males have even been known to enter the pocket of an entomologist, who had a female moth thus secured in a box! In many species of *lepidoptera*, the females are also destitute of wings, and the males are captured in a similar manner to the above.

With the eggs, I also send you a caterpillar; you will observe how curiously it is covered all over with hairs and feathers. Likewise specimens of the male and female moths. I also send a few eggs from the oak-egger moth; I have, from good authority, been informed of a singular circumstance in the economy of nature respecting the preservation of this species of insect. It appears, that the female lays a certain number of eggs at one time; the caterpillars are also excluded from them nearly all at one time; and after feeding their usual period, they pass into the crysalis state. The first year, a few moths only come forth;

the following year produces a few more; and again, in the next year, others come out; but it is not until the seventh year, that the whole are produced! Although it appears above that the caterpillars went into the crysalis state at about the same time. Does not this mode of preserving the species of insects show the mysterious ways of the Almighty even in his smaller works?

With these you will also receive a few eggs from the cabbage butterfly, the Atlas moth, and the magpie moth; the characters in these are very singular. Also some from the gypsy moth, very curiously embedded amongst hairs, produced from its own body, it thus forming a nest to lay them in; a wise provision of nature for the preservation of its offspring. Also some other eggs from the buff-tip moth; in the centre of each egg, you may observe an indentation or opening, which is covered over with a thin film or skin, to protect the caterpillar while within it, and also to afford it an easy way of breaking its way through the egg. There are likewise some other very singularly marked eggs, which I found attached to the twigs of the hazel and blackberry; and some others which had been deposited upon a ripe currant.

In order to point out to you the amazing number of caterpillars which are produced from a single moth or butterfly, and which, if not kept within due limits, would destroy all our vegetation, I send you the bodies of a moth and of a butterfly, laid open, and in which you will observe that every part of the interior is full of eggs. These are not solitary instances, as the bodies of all the female moths and butterflies are filled with eggs in the like manner.

In Kirby and Spence there is a very interesting statement of the number of eggs laid by various insects; the *musca meridiana*, a common fly, lays two; other flies, six or eight; the flea, twelve; the burying beetle, *nicrophorus vespillo*, thirty; may flies, under a hundred; the silk-worm moth, about five hundred; the great goat moth, *cossus ligniperda*, one thousand; *acarus Americanus*, more than a thousand;

the tyger moth, *callimorpha caja*, sixteen hundred; some *cocci*, two thousand; others, four thousand; the female wasp, at least thirty thousand; the queen bee varies considerably in the number of eggs that she produces in one season, in some cases it may amount to forty or fifty thousand or more; a small hemipterous insect, resembling a little moth, *alcyrodes proletella*, two hundred thousand. But all these are left far behind by one of the white ants, *termes fatali*, *F. bellicosus* of Smeathman, the female of this insect extruding from her enormous matrix not less than sixty eggs in a minute, which makes 3,600 in an hour, 86,400 in a day, 2,419,200 in a lunar month, and the enormous number of 211,449,600 in a year! Probably, indeed, she does not always continue laying at this rate; but if the sum be set as low as possible, it will yet exceed that produced by any other known animal in the creation. The sturgeon is said to lay 1,500,000 eggs; and the cod fish 9,000,000. In the British Museum there are several specimens of the above insect, whose abdomens are distended to an amazing size, they are completely filled with eggs.

I also send you the egg from a large species of grasshopper, and the bodies of two of these insects, which you will find are filled with eggs; together with a few eggs from the common gnat. With these you will likewise receive the head and thorax of a moth, which are covered with a profusion of delicate scales and feathers; together with parts of other moths, displayed as proper objects for the microscope. Likewise several minute moths, of most exquisite beauty, and which are profusely adorned with fine metallic coverings. Among these are several specimens of the *semi argentella*. You will observe, that in the upper wings of these minute insects, there is a wonderful combination of all the varied shades of molten silver, and burnished gold; they being entirely adorned with plates, which exhibit in one view the appearance of those costly metals; but by varying the light from the speculum, they

will give different shades of the most exquisite colours! There is also the head of a very singular moth, it having two single eyes, placed on two pillars, situated at the back part of each of its two numerous compound eyes.

I have likewise sent a species of *panorpa*, usually termed the scorpion-fly; the various parts of this fly are well adapted to fit up as microsccpic objects: the wings may be viewed as transparent objects; the head, with its singular beak-like appearance, and the organ at the end of its abdomen, as opaque objects; and they will afford you much entertainment in the examination of them.

I also send you a species of one of our large gnats, which severely bit me last summer, and have set its jaws open, in order that you may observe the great power of these parts. Also another species of ants, from Africa, accompanies this. You will perceive what capability these insects have for committing depredations; and when marauding in prodigious numbers, as is the case in the warmer climates, scarcely any thing can withstand their united attacks. This, I believe, is one of the visitation ants mentioned by me in your third volume, page 271. In addition to the tremendous jaws with which it is furnished, you will also perceive a formidable sting protruding from its abdomen; it also injects a poisonous fluid into the wounds it makes, the pain from which I have been informed is intolerable. Of this you will have no doubt, when you examine the insect.

You will find the numerous species of curculios to be exceedingly interesting on examining them under your microscope. The various markings, and splendid scales with which some of them are profusely adorned, have a fine effect when viewed under the opaque speculum. I send you a specimen which I bred from the water betony, *curculio scrophularia;* this insect is very curiously marked. With it I also send a portion of the plant, in which you will observe in what manner the seed of the plant has been eaten by the insect in its larva state. Also the case it spun when

changing into the crysalis, and the exuvia or cast skin within the case, thrown off previous to its becoming the perfect insect.

With this I likewise send a few curculios from the marsh mallow; the wing-cases of these you will find worthy your observation. As also those of *C. nigrorostris;* with a few others, which I found on a wild plumb-tree. The proboscis of these are very long, and they are polished like black ebony. These I observed to run much faster than most other species of curculios. Others that I send I found on the mallow and the sallow tree. Also some exceedingly minute ones, from the furze; these latter are curiously marked with hairs and longitudinal furrows on their wing-cases. I also send *C. rumices,* with a singular case wove by the larva prior to its changing into the pupa state. Likewise a few from the willow tree, *C. maculatus.* These I bred from the larvæ, by feeding them on the bloom of the tree, until they went into the crysalis state, and eventually came forth the beautiful insects you now receive. You will find among those I send for your examination a great variety taken from the oak, possessing much splendour in colour, and particularly *C. argentatus.* I had frequently heard, from collectors, much praise bestowed on *C. Bacchus,* for its unrivalled beauty; and was therefore very anxious to procure a specimen or two of it; but after diligently searching for several years, I met with no success, owing to the scarcity and locality of the insect: however, that I might not be altogether without one, I purchased a specimen, and, on comparing it with some brilliant curculios in my cabinet, I found it very inferior in splendid colours to many of our common species; indeed, it falls infinitely short in beauty to *C. nitens,* or *C. argentatus,* in my opinion; and I have no doubt that when you compare the specimens, you will agree with me. With *C. Bacchus* I have also sent a wing case of *C. imperialis,* for you to compare the two together; this last is decidedly the most beautiful of all the coleopterous insects; it is so rich, when

placed under the microscope, that it dazzles the eye with more splendid refulgence and brilliancy than ten thousand diamonds would when set in gold.

I likewise send you several species of the genus *elater* for your examination. Many of the coleopterous insects have a great difficulty in restoring themselves when laid on the back; the apparatus with which the insects of this genus are provided for that purpose, is singular and curious. An elastic spring or spine projects from the hinder extremity of the breast; and there is a groove or cavity in the anterior part of the abdomen. When laid on its back, the insect raises itself on the anterior part of the head, and the extremity of the body; by which means, the spine is removed from the groove, where it is lodged when in its natural position; then suddenly bending its body, the spine is struck with force, across a small ridge or elevation, into the cavity from whence it was withdrawn; by which shock, the parts of the body before sustained in the air, are so forcibly beat against whatever the insect is laid on, as to cause it to spring or rebound to a considerable distance. The antennæ are lodged in a cavity, scooped out of the under side of the head and thorax, probably to preserve them when the insect falls after its singular leap. The experiment of their leaping may be proved by placing a living insect of this genus on its back in your hand.

There are near two hundred species of this genus of insects now ascertained, of which near thirty are found in England. They are all easily distinguished from every other genus, by the spine at the extremity of the thorax; a character which scarcely any other insect possesses. The *phosphoreus*, the *noctilucus*, and several other species of this genus, give out a strong phosphoric light in the night time, and which is so luminous, that a person may see to read the smallest print, by placing them on the leaf of a book! Among those I send you will find *E. noctilucus.* This remarkable insect is called in South America, where it is not uncommon, *cocujus.** It is about an inch and a

half long, and of a brown colour, with the thorax marked on each side by a small yellow transparent spot. These spots, like those on the abdomen of the glow-worm, are highly luminous, diffusing during the night so brilliant a phosphoric splendour, that a person may with great ease, as before observed, read the smallest print by the insect's light, if held between the fingers, and moved along the lines; but if eight or ten of them be put into a clear phial, they will afford a light equal to that of a common candle! It is said that the inhabitants of Hispaniola, &c., before the first arrival of the Spaniards, made use of no other light than that of these insects; and we are informed by Mouffet, that when Sir Thomas Cavendish and Sir Robert Dudley (son to the Earl of Leicester), first landed in the West Indies, and saw the same evening an infinite number of moving lights in the woods, they supposed that the Spaniards had advanced upon them unawares, and immediately betook themselves to their ships! to this story you will give what credit you may think it deserves.

You will also find with the above species, *E. obscurus*; the larva of this is too well known by the name of the wire-worm, and is a dreadful pest; it causing annually a large diminution of the produce of our fields, destroying indiscriminately wheat, rye, oats, and grass. When we are told that it lives in this state not less than five years, during the greater part of which time it is supported by devouring the roots of grain, you will not wonder that its ravages should be so extensive, and that whole crops should sometimes be cut off by it. As it abounds chiefly in newly broken up land, though the roots of the grasses supply it with food, yet it probably does not do any great injury to our meadows and pastures.

There are many other species of insects besides those before mentioned, which give out a strong phosphoric light; but the most vivid of all the luminous insects, is the great lantern fly, *fulgora lanternaria*, one of which I now send, together with another species, *fulgora candelaria*. The

former insect affords a light so great, that travellers walking by night are said to be enabled to pursue their journey with sufficient certainty, by three or four of them being tied to a stick, and carried in the manner of a torch! It is common in many parts of South America, and is described by Madam Merian, in her superb work on the insects of Surinam. She gives an entertaining account of the alarm into which she was thrown by the flashing light which proceeded from them in the dark, before she had been apprized of their shining nature.

"The Indians once brought me (says she), before I knew that they shone by night, a number of these lantern flies, which I shut up in a large wooden box. In the night, they made such a noise, that I awoke in a fright, and ordered a light to be brought, not being able to guess from whence the noise proceeded: as soon as I found that it came from the box, I opened it, but was still more alarmed, and let it fall to the ground in my fright, on seeing a flame of fire come out of it; and as many insects as came out, so many different flames appeared. When I found this to be the case, I recovered from my alarm, and again collected the insects, much admiring their splendid appearance." "The light," she adds, "of one of these insects, is sufficiently bright, that a person may see to read a newspaper by it."

The light emitted by the fire-fly, proceeds entirely from the hollow part or lantern of the head, no other part of the insect being luminous. Dr. Darwin conjectures that the use of this light is merely to prevent the insects from flying against objects in the night, and to enable them to procure their sustenance in the dark. He seems, however, not to have considered, that very few of the numerous train of night insects are possessed of this luminous property, and all the functions of these are performed with perfect regularity. Its most essential use is, no doubt, as in the other luminous tribes, to point out the sexes to each other; thus serving in them the same purpose, in this respect, as the

voice does in the larger animals. The head in this species is large, and somewhat oval. The wings are variegated, and the lower pair are each marked with a large ocellated or eye-like spot. Sometimes the insect is seen of three or four inches in length.

Accompanied with the foregoing opaque objects, I likewise send you a few transparent ones; among which you will find dissections of the ovipositors of various species of cynips and ichneumons; a few cast-skins from various aquatic and other insects; some dissections from the shepherd spider; within the same slider, is also the dissected sting of a small ant; the dissected piercer or rostrum of the water insect, *hydrometra stagnorum*, described by me in your last volume, page 195; a dissection of the tongue or trunk of a fly, *dioetria rupifes;* the tongue and three instruments, taken from a groove within it, are placed between two slips of glass, and which also contain the eyes from the same fly; these are very singular, and differ very much in size and shape, some of them being lozenge-shaped, some square, and others hexagonal; and between the same glasses are the antennæ, &c.; and also dissections from small *cimices;* and the wing-cases of the *curculio granaria*, are between other slips of glass. Also a portion of a coccoon, spun by a caterpillar, previous to its passing into the pupa state within it; the fine threads of which this part of the case or coccoon is composed, are displayed so as to show their characters. Also other portions of the crysalis case of another species of moth, in which are seen some exceedingly fine characters in the cast-skin from the pupa. Between other slips of glass, are some larvæ of a species of moth, enclosed within cases formed by themselves; these, with numerous others, I found feeding on the feathers of a large mackaw, which had been stuffed, and placed in a glass case. The plumage of the bird, about a twelvemonth previous, was in a fine state of preservation; but at the time I saw it, there was scarce a particle of feather left upon any part of it; these insects had

completely stripped it, and left it a perfect skeleton. Some of these larvæ are partly out of their cases; and in one of them its jaws are distinctly seen. There are also two skins of the crysalids, from which the moths came forth. In one the insect had left many of its scales or feathers; these scales, and other parts of the case, afford very interesting objects. Between other glass slips, are the jaws from a larva of the dragon fly; some curious antennæ from a small species of *staphalinus*, &c. &c.

In sending you the various objects mentioned in this letter, I furnish you with much employment for your microscope; and when you have examined these, I hope to have the pleasure of forwarding others to you equally worthy of your investigation.

I remain, dear sir,
Your obliged friend,
THOMAS CARPENTER.

To T. GILL, *Esq.*

Remarks and Additions. By the EDITOR.

In plate III. fig. 1 is one of the curious antennæ of a species of *staphalinus*, consisting of a series of hairy bulbs, which, in all but the two nearest to the root, are united by a double series of necks or stems, in a very singular manner.

Fig. 2 is a beautiful oar, seen in the exuvia of a species of boat-fly, and in which its very singular structure is finely displayed. It is furnished with two strong bent spines at its extremity, and likewise with rows of long hairs, each proceeding from a bulbous root, besides numerous shorter hairs, and appears admirably calculated for its use in presenting a concave hairy surface to the water, on that side of it which is intended to act upon it, in propelling the insect forwards; whilst its other side is made smooth and rounding, to present the least resistance to the water.

Fig. 3 represents part of the cleft proboscis, and three instruments lodged in a groove formed along it, of that curious insect, *hydrometra stagnorum;* the singular posi-

tion of whose compound eyes, in the middle of its apparent neck, was described in vol. V. pages 195 and 197; and exhibited in plate IV. fig. 9 of that volume. One of these instruments is still lodged within the cleft in the proboscis or rostrum; the other two are dislodged from it, and are both pointed and finely serrated instruments.

Fig. 4 represents a cleft proboscis, and four instruments usually placed within it, of an insect, the *dioetria rupifes*; one of them a broad lancet shaped blade, is still remaining within the cleft of the rostrum; but the other three curved, pointed, and serrated instruments, are removed from it. One of these has a thin web attached to it; and another is furnished with a kind of brush; the whole are admirably adapted to perforate the flowers of plants, and to extract their juices, upon which the insect feeds.

Fig. 5 exhibits part of the beautiful granulated wing-case of the *curculia granaria*, or corn weevil, in which its very singular structure is seen. A magnified view of this destructive insect is given in plate I. of vol. IV. fig. 2, and its history in page 12 of that volume.

Fig. 6 represents a concave and convex egg of the vapourer moth; they are of a pale yellow colour, with a spot of a deeper colour in the centre of each; and are granulated all over their surfaces.

Fig. 7 exhibits a portion of the shell of the egg of an insect, found by Mr. T. Carpenter, deposited upon a red currant. The shell is of a pale metallic or cupreous tint, and is beautifully reticulated in an hexangular manner, with white spots in the angles, as represented in our figure.

Fig. 8 represents part of the compound eye of a moth, dissected by Mr. Curtis, the entomologist, and which has another single eye, of a beautiful black and shining appearance, but with a white iris, placed by the side of the compound eye, at the front of its head. These additional eyes have never been found by Mr. Curtis in any other species of moth.

Fig. 9 is part of the head and the rostrum of an insect,

the *panorpa*, resembling the beak of a bird, and having several instruments partly protruded from its outer end, employed by the insect in lacerating the flowers, upon the juices of which it subsists.

Mr. Thomas Carpenter has lately employed our artist in making a beautiful coloured drawing of the fringed disc or hand of a *dyticus* or large water beetle, upon a highly magnified scale; and in which its two fringed lesser discs, and numerous transparent hemispherical cups, each mounted upon a stem, are admirably shown, as well as other curious particulars of its wonderful structure; and we sincerely wish it came within our limits to cause it to be engraved for our work. He has likewise made drawings for Mr. T. Carpenter of the singular appendages at the abdomens of various flies and wasps.

(*To be continued.*)

XXIX.—*On an Insect found in a Cavity formed in a thick piece of Spanish Cedar.*

WITH FIGURES.

In plate III. fig. 10 is a top view, and fig. 11, a side view, of the larva of an insect, of its natural size, which was found in a living state, in sawing through a thick piece of Spanish cedar; although it died in the course of an hour after its exposure to the open air, possibly owing to its being injured by the saw. It is supposed to be the larva of a species of *buprestes* or *cerambyx*.

It had formed a cavity in the timber, which was but little larger than to admit of its turning round in it. It was full of a juicy matter, and had hard and black jaws, evidently made for making incisions in solid materials. We have selected these two figures from "The Olio."

XXX.—*Recollections of his Father, the late Mr.* THOMAS GILL. *By the* EDITOR.

(*Continued from page* 98.)

IN order to afford our readers an idea of the wretched state to which the manufacture of English sword blades was reduced, previous to Mr. Gill's patriotic and successful endeavours to restore to his country this highly important branch of its manufactures, we shall make some extracts from a scurrilous paper, published by three of the principal London sword dealers, in the year 1787; in which they wisely labour to depreciate the character of the English sword blades, in order to exalt those of German manufacture.

"*Important facts addressed to the Officers of the Army.*"

"The superior excellence of the German sword blades has been attested by our officers for a century past, during which period many attempts have been made to bring the British to the same state of perfection. The first adventurer was a German, supplied with German materials, and assisted by German workmen. The manufactory was at Newcastle upon Tyne. From principles of policy, the government gave all the encouragement possible to the enterprize, and a prohibitory act was passed in its favour; but it proved abortive. Similar attempts were afterwards made by Englishmen, at Hounslow, and Lewisham; but with no better success. Convinced, by repeated trials, that the design was impracticable, the manufacturers, we mean those of integrity and skill, candidly acquiesced in the superiority of the German blades. But one GILL, of Birmingham, publickly declares, he can furnish the army with better blades than the Germans themselves. To establish this point, he appeals to a trial at the India house. But it is easily manifested that no credit is due to Mr. Gill, and that the proof at the India house, was an imposition on the

honourable company, and a flagrant act of injustice to his neighbours at Birmingham!

"A copy of this imperfect test has been introduced into the public papers. But as the affair is of national importance, it is greatly to be wished that a Court of general officers would condescend to determine the relative excellence of German and British blades. For it is not doubted, that those who pay a professional attention to the form and temper of swords, and spend their lives in the use of them, will form the most respectable and disinterested Tribunal to which an appeal can be made *.

"That we cannot use the British swords in the field of action, but at the peril of the military glory of this country, and the lives of our bravest troops, is founded on the sacred and indispensable evidence of general ———, who solemnly avers (in his memorial to the Lords of the Treasury), that when he commanded the Royal Regiment of Horse Guards, in Germany, the broad swords which he received from Birmingham were so unfit for service, that several of them were absolutely broken in action; that his own sword was in a very imperfect state, through the want either of honesty or ability in the maker, and that his men suffered greatly on the occasion.

"Similar instances occurred frequently in America. And that the Birmingham people have not even now the power to remedy these defects, is evident from the case of one of the Regiments of Dragoons, lately quartered at York. It was furnished with swords at the commencement of the present year (not by Mr. GILL, however, EDITOR); a particular pattern was ordered, and as the time would not permit of an application to Germany, so the London tradesman was under a necessity of procuring them from

* Mr. Gill had afterwards the *pleasure*, and the London sword dealers the *great mortification*, of having a comparative trial made of his sword blades with those of Germany, and of other English makers, by command of his late majesty, before a Board of General Officers, at the Horse Guards; when the great superiority of those of his manufacture appeared still more manifest than upon the former trial.

Birmingham. At this moment, not one in ten remains unbroken!!!

"It is easy to conceive what carnage would ensue, if men were to charge an enemy with such weapons as these.

"The present experience of this regiment has not only destroyed their confidence in the Birmingham manufacture, but it may repress their ardour in the field of battle, even though they have a German blade in their hands. The very idea of being disarmed and exposed to the enemy after the first or second stroke, is sufficient to fill the bravest heart with terror."

It is somewhat singular, and not unworthy of remark; that, in the year 1779, when a petition was presented to the Board of Ordnance, to supply them with German swords, under the fallacious idea that those of England were inferior; Mr.————————, father to one of the gentlemen whose signature is subjoined to the foregoing paper, was called to the Board of Ordnance, and his opinion of the swords of English and German manufacture desired; when he clearly proved to the entire satisfaction and conviction of the Honourable Board, that Mr. Gill's were equal in goodness to any foreign swords whatever; and the petition was rejected accordingly. What motives could influence the son, nine years afterwards, to decry his father's judgment, is left for the public to decide!

It having been hinted at the two comparative trials respecting the merits of Mr. Gill's sword blades and those of German and other English manufacturers, that the chief cause of his great superiority was the partial conduct of the person who struck his blades upon a cast-iron plate; he declared that he would make a machine to strike them, which could not, of course, be liable to such an imputation; and, accordingly, he invented and caused such a machine to be constructed. This machine had two powerful spiral springs similar to those of time-pieces, but much broader, and longer, of course; indeed each of them was twelve inches in breadth. The inner ends of these springs were

united to an axis, turning upon necks or pivots at its ends, which moved in holes or bearings formed to receive them, in the cast-iron frame of the machine. Between the two springs, a cast-iron substitute for the hands of the person who before struck the sword-blades upon the cast-iron plate, was affixed upon the axis; having two iron staples upon it, to receive the tangs of the sword blades within them, and which were firmly held therein, by two binding screws. One end of the axis of this machine projected beyond its pivot-hole, and had a ratchet-wheel affixed upon it, into the teeth of which a click, having a long handle affixed to it, was lodged. Upon winding up the springs, by means of a winch or handle, affixed upon the axis of the machine, the sword blade, held in the manner above mentioned, was brought from its horizontal position, when lying upon the cast-iron plate, and carried as far round, in an opposite direction, as was judged proper, or according to the kind of sword blade to be struck; the click retaining it in that position, until its handle being elevated, set the springs at liberty to strike the blade upon the cast-iron horizontal plate, with the requisite degree of force. This machine answered its purpose most completely, and entirely removed the chance of any unfairness being practised, in the proving of the quality of any sword blades tested by it; and all the sword blades made and warranted subsequently by Mr. Gill, were capable of enduring the severity of its strokes! The Editor recollects inscriptions being etched upon the upper surfaces of the springs, stating, that "all of Gill's warranted sword blades, are of the same excellent qualities of steel and temper as these extraordinary springs."

We would here appeal to our readers, and ask, what would have been the fatal consequences of our being obliged to procure our sword-blades from Germany, frequently occupied bythe enemy, during the long continued wars in which we have since been engaged; an !, as recommended by the worthies, who signed the above paper? And, con-

sequently, how greatly the British empire is indebted to the praise-worthy exertions of that individual, whose sole endeavours completely obviated the necessity of our being reduced to such a pitiable state, and who indeed, completely turned the scale of merit in our favour; and especially, since the introduction of the sword exercise, by Colonel Le Marchant, which has given such a decided superiority to this important weapon!

Should public circumstances require it, the Editor, who, in consequence of the death of all his brothers, excepting the two youngest, who lost their father in their infancy, is, now the sole depository of his late father's great and successful practices in the manufacture of his superior articles, would be glad to have the opportunity of reviving those practices, with such additional improvements as he has added to them in the course of his great experience in the difficult art of treating steel.

In the progress of publishing the *Technical Repository*, and the *Technological Repository*, our readers must have frequently observed notices by the Editor of improved processes, followed by his late father and himself, in the working of iron and steel. These, although of high importance, can, however, convey but little knowledge, comparatively, of the actual methods of carrying them into practice; and which, indeed, nothing short of actual experience can possibly effect.

It is indeed true, that in consequence of the example afforded by the Editor's late father, the qualities of English sword-blades, made by other persons, were considerably improved, in order that they might be rendered capable of undergoing the increased severity of the tests to which they were subjected. Still, however, no one but one educated in the extensive knowledge possessed by his late father, can possibly be enabled to carry his improvements into complete effect.

(*To be continued.*)

XXXI.—*On Silicate of Iron**.

A DISCOVERY of the greatest importance to the manufacturers of steel, has lately been made by the respectable Dr. Eynard, of Lyons, who, at the age of more than eighty years, has not only preserved all the faculties he enjoyed when but forty years old, but is likewise continually occupied in whatever can aid the advancement of the arts and manufactures.

His cabinet is equally accessible to the humble artizan as to the learned; and is a true laboratory, where he affords, with a noble disinterestedness, his useful advice to those workmen who may need it.

It is now some months since, and after the ingenious experiments of Conte, that, wishing to restore their cutting properties to some files, he plunged them for several days into a mixture of five parts of water and one of sulphuric acid. Upon removing the files, it was with astonishment that he found the bottom of the glass vessel contained a matter of a greyish-white colour, and of a shining appearance. He decanted the liquid, and collected and dried this matter. He found it to be pure silex, soft and silky to the feel, like amianthus. He collected enough of it to be enabled to send some to M. D'Arcet at Paris, in order that he might call the attention of the learned to this interesting discovery.

In fact, although it is considered at present, that in the cementation of iron, in order to convert it into steel, the change is effected by means of carbon or charcoal; yet we recollect that M. Clouet converted iron into steel by means of the diamond; and also, on the other hand, that he obtained very fine steel by cementing it with alumine and pure silex.

In the year 1732, the brothers Perru, of Neufchatel, in Switzerland, manufactured draw-plates, and rollers or

* From De Moleon's *Recueil Industriel*

cylinders, of steel, for reducing gold and silver. These cylinders were so hard, as to resist the effects of the file, and yet had a high polish; they were, it is said, fused with silex. It has been found impossible to imitate them at the present day; and a pair of cylinders, five inches in diameter, of their manufacture, sell for 2,400 francs!

M. Boncingo, employed in the mines of St. Etienne, published in the sixteenth volume of the *Annales de Chimie*, some notices on silex united with steel; he pretended that iron contained none; but he only spoke of plate-iron, and not of the white cast iron; and his experiments were not carried far enough to possess much interest.

It is now several years since a founder from Auvergne, settled at Lyons, cast sauce-pans in white iron, of an extreme hardness; and from some fragments of these, M. Culhot, an ingenious Lyonese workman, cast cylinders, so very hard, that it was found impossible to dress and polish them with the usual cutting instruments; and it could only be effected by means of metal collars, supplied with emery, putty, &c.; and then it took two months to effect it! The founder did not use any carbon in fusing them; but what he did employ, he kept a secret.

M. Eynard has found silex in a granular form in cast-iron, consisting of pieces of rollers, for laminating iron; but not in wrought or forged iron. He insists that it is essential to learn:

1st. Whether the cementation or conversion of iron into steel, be owing to the carbon, or rather to the silex which encloses it?

2ndly. What weight of silex does steel contain?

3rdly. Whether, on cementing iron without the use of carbon, but with pure silex, steel would be produced?

4thly. Whether, on the contrary, extracting the silex from steel, and then melting it anew, would produce pure steel, or rather that the steel would be reduced to th state of iron?

5thly. In what proportions should the silex be mixed

with iron, in order to obtain a perfect and very hard steel?

6thly. Whether the common soft cast-iron would become white and hard by the addition of a given quantity of silex?

These various experiments, made with all the care of the fusions in metallurgy, would lead to results highly important to our steel manufacturers.

Remarks. By the EDITOR.

We trust that these important suggestions will be attended to; as it is an undoubted fact, that both during the cementation of iron, to convert it into steel, and during its fusion into cast-steel, it is enclosed in, and surrounded by, alumine and silex, which enter into the composition of the chests and melting-pots.

XXXII.—*On Preserving the Skins of Animals.*

A CORRESPONDENT in "The Olio," states, that the best method of preserving the skins of animals, is the following: carefully clean away all the fat, and stretch the skin tight, either upon a flat board, with nails, or, if wet, upon a frame, with whip-cord; it is then to be placed in a dry place, and the flesh side of the skin to be well rubbed with a small quantity of finely pulverized alum; this is to be occasionally repeated, and the skin is to be suffered to remain till it is become dry. If it came off a fat animal, after it is as dry as it can be rendered, it must be placed in a canvass bag, filled with plenty of clean dry saw-dust, and be well beaten with a flail for several hours daily, for the space of a week; this will render the skin soft and clean, and give it a beautiful texture. The saw-dust should be changed daily. This mode of cleaning skins is adopted by the crews of Greenland ships; and was also employed by Joshua Brookes, Esq.

Remarks. By the EDITOR *of the Technological Repository.*

The Editor was informed by Mr. J. Wornell, of Ernest-street, Regent's Park, lately animal preserver at the British Museum, that burnt alum is best for the above purpose; and that such is its astringent quality, that it will speedily drive out all the fat and moisture from the skins rubbed with it; and that it is employed by the North American Indians, for the purpose of preparing them for their various uses.

XXXIII.—*On a fine Scarlet Pigment. By Mr.* A. A. HAYES, *Roxbury Laboratory* *.

WHILE prosecuting some experiments on the pigments employed by artists, I prepared a quantity of the bi-iodide of mercury; and gave it to Mr. Rembrandt Peale, of Philadelphia, requesting him to make some trials of its working properties and permanency. This distinguished artist obligingly commenced them, but they were not finished at the time he left this country. He found that it readily mixed with oil; combined with other colours, it gave delicate and beautiful shades, and exposed for weeks to the direct rays of a midsummer's sun, it remained unchanged. These properties induce me to recommend it as an addition to the number of pigments, among which the artist can make a choice.

An economical process for preparing this salt, consists in boiling a mixture of 125 parts of iodine, and 250 parts of clean iron filings, with 1000 parts of rain water, in a Florence oil-flask. When the brown colour of the liquid is succeeded by one of a light green, the clear fluid is to be decanted, and the residuum washed with warm water, the washings being added to the green solution; 272 parts

* From Silliman's American Journal.

of corrosive sublimate dissolved in 2000 parts of warm water, are then to be added to the former liquid, and the resulting precipitate is to be afterwards washed and collected.

This salt, either in crystals, or in powder, presents two distinct and beautiful colours. If the precipitate, obtained as above, be heated in a small subliming apparatus, or in a glass tube, it melts and sublimes copiously, and the vapour is condensed in large transparent rhombic tables, of a fine sulphur yellow colour. These crystals are permanent in the air, and unaltered by the direct solar rays; but the slightest friction, or the touch of a fine point, is sufficient to alter their interior arrangement. The point of contact instantly becomes of a rich scarlet colour, and the same colour spreads over the whole surface of a single crystal, and soon extends to their most remote angles, if a group of crystals be the subject of experiment. This change of colour is accompanied by an evident mechanical movement, so that a small heap of the crystals appears as if animated! An ordinary electroscope, does not, however, indicate the developement of any electricity, nor is there any considerable elevation of the temperature, during the change.

By gently warming the crystals, supported upon paper, over the flame of a lamp, the original yellow coloured salt is again obtained; and the same experiments may be often repeated, affording an elegant illustration of the connection between colours and the mechanical structure of bodies. Transparent, but minute, rhombic prisms of this salt may be obtained, by allowing a hot solution of it, in a solution of corrosive sublimate, to cool very gradually.

XXXIV.—*On the Use of Alumina, in Pigments. By Mr. A. A. Hayes, Roxbury Laboratory*.*

In preparing his colours by levigating pigments in oil, the artist is often perplexed by the diversities which they exhibit, after this operation. Some pigments present a chemical combination with the oil, while others can only be suspended in it by considerable labour, and soon separate again, when left at rest. These differences can, however, be rendered of but trifling importance, by employing such a substance as will retain those compounds which possess no attraction for the oil, in a state of uniform suspension, and whose action will be in some respects analagous to that of gum, used in inks and water-colours. The property which the hydrate or carbonate of alumina possesses, of mixing freely with oil, so as to form a transparent, coherent, and almost colourless compound, admirably fits it for this purpose. At the request of Mr. Rembrandt Peale, I prepared some pigments by mixing them with alumina while moist. When dried and ground with oil, he found them to possess all the most valuable properties of the best colours. The tendency to separate from the oil, and the disagreeable property which some colours possess of becoming more fluid when an attempt is made to preserve them, by keeping the palette under water, disappear after they have been ground up with a small portion of alumina. The artist has it thus in his power to diminish or increase the fluidity of his colours, and to render them uniform. Some pigments become valuable as glazing colours, such, for instance, as the Prussiate of copper (Hatchet's brown). While vermillion and Naples yellow thus acquire new properties.

For printing from blocks, as in the manufacture of floor-cloths, it is often desirable to increase the fluidity of the colours, so as to prevent the dropping of small thread-like parts on the work, and yet without causing the colours to

* From *Silliman's American Journal.*

spread. This may be accomplished by adding a small quantity of whiting to the pigment while grinding it; the workman can then load his blocks with colour, and, consequently, give a thick coating to the impression or print made by it.

XXXV.—*On a singular Galvanic Pile. By Mr.* F. Watkins, *Philosophical Instrument Maker, London*.*

This pile is constructed with a single metal only, and without the use of any liquid. It consists of from sixty to eighty plates of zinc, each four inches square, fixed in a wooden trough or frame, at a short distance from each other, and having only a thin plate of air between them. One side of each plate is smoothed and polished, but the other side is left rough. The polished faces are all turned in one direction. If one extremity of the pile be made to communicate with the earth, and the other with an electroscope, the latter will immediately indicate the presence of one or the other of the two electricities, according to the pole with which it is brought in contact. The humidity of the air favours the action of this pile, which may be considered as a kind of dry pile, in which the air is substituted for the usual paper discs; and the two surfaces of the zinc plates perform the office of the two heterogeneous metals usually employed. It appears to be to the stronger oxidation of the polished surfaces of the zinc plates, that we are to ascribe the developement of electricity in each plate; the intermediate strata of air, and perhaps the frame, permitting this electricity to accumulate, as in the ordinary pile.

* From *Annales de Chimie et de Physique.*

XXXVI.—*On a new Use of the Chromate of Potash. By M.* Kaechlin-Schouch*.

The new use of this chromate is to print a white pattern on a blue or green ground. A blue dye is first given to the cloth, by means of the indigo vat, more or less deep, according to the green required ; the cloth is then prepared with the aluminous mordant, and passed through hot water, it is then again prepared with an ungummed solution of bichromate of potash, consisting of two and a half ounces of salt, to four pints of water. It is then printed with the following preparation :

Water thickened by roasted starch .	4 pounds.
Tartaric Acid	10 ounces.
Oxalic Acid	6 ounces.
Nitric Acid	2 ounces.

The nitric acid is unnecessary, except for delicate designs. The moment this substance is printed, the blue colour is destroyed ; the cloth is then instantly put into running water, and afterwards dyed in quercitron, or other dye stuffs.

This destruction of vegetable colour arises from the following general fact : whenever chromate of potash is mingled with tartaric or oxalic acid, or with a neutral vegetable substance, and a mineral acid, as the sulphuric or nitric, a strong action takes place, accompanied with the disengagement of heat and gaseous substances. The principal product of this reciprocal action, is a new body, having acid properties. During the effervescence which takes place, the mixture has the power of destroying vegetable colours. Carbonic acid is evolved during the decomposition ; and, when the mixture is made in a retort, there comes over a colourless liquid (formic acid), slightly acid, having the

* From *Ann. de l' Industrie.*

odour of weak acetic acid, and reducing the nitrates of silver or mercury if heated with them.

When nine parts of tartaric acid, and ten parts of chromate of potash are boiled with water, a neutral green liquid is obtained, which being evaporated, does not crystallize, but becomes a brittle green mass. When acetate of lead is added to the solution, a precipitate is formed; which, being well washed, and then carefully decomposed by sulphuric acid, yields a very acid green fluid, uncrystallizable; and, with alkalies, forming either acid greenish-violet coloured salts, or neutral green salts. Cold sulphuric or nitric acids do not act upon this substance; but being heated, they decompose it. When the acid itself is calcined, it yields a green oxide of chrome.

XXXVII.—*On an Improvement in Fusing Tallow* *.

The Council of Health, at Nantes, has been engaged in an investigation of the best means of fusing tallow, so as to avoid the annoyance which arises from an abundant liberation of stinking vapours, when the ordinary method is used. Much pains have been taken, in acquiring all the information possible, and numerous experiments have been made, both on a large and small scale. The best process which the Council has tried, appears to consist in using, according to M. D'Arcet's suggestion, a certain proportion of sulphuric acid, and operating in close vessels. By the use of the acid, the fumes always evolved, are very much altered, and ameliorated in their smell; and at the same time that the fused tallow is both improved in quality, and increased in quantity, the fusion is very much quickened, and the use of a press dispensed with. By the employment of close vessels, the fumes evolved, can either be conducted to a fire-place to be burnt; or, if that may be thought dangerous, in consequence of the occasional boiling over of the

* From the *Ann. de l'Industrie* and the *Franklin Journal*.

melted tallow, they may be conducted into a condensing apparatus, and which is found to condense them readily.

M. D'Arcet uses 100 parts of ctude tallow, cut into small pieces; fifty parts of water, and one part of sulphuric acid sp. gr. 1,848. In some small experiments, a digester was used, having a copper plate pierced full of holes, near the bottom of it, to avoid the necessity of stirring; 1500 parts, (516.5 oz.) of crude tallow, 750 of water, and 124 of oil of vitriol were used, and the fumes conveyed through a pipe into a fire-place, half an hour's ebullition completed the fusion. The infusible matter, when pressed through a cloth, weighed only ninety-six parts, and was slightly acid. The tallow was white, hard, and sonorous, and not acid. Without the acid, the same effect was not produced in an hour.

A tallow-melter tried the experiment with two cwt. of tallow, using the acid, but operating in open vessels; ninety-two per cent. of fused tallow was obtained, and eight of loss occurred. In a second experiment in the large, with acid, only a loss of five per cent. was occasioned. The residuum does not require the use of a press, but it cannot be made into oil-cakes for feeding cattle, unless previously freed from acid by washing it.

Experiments made on condensing the vapours, were found to succeed well, and thus all fear of injury from fire, is avoided. The Council propose conducting the vapours into the drains of the works, and condensing them there; no annoyance being apprehended from the occasional return of the vapours into the building, as that effect can be counteracted, by the use of stink-traps.

XXXVIII.—*On Colza Oil* *.

The following is an extract of a letter from Mr. Thomas G. Clemson Esq. at Paris, to Jacob Green, M.D. professor of chemistry, in Jefferson Medical College, Philadelphia, dated September 18, 1828.

" Dear Sir,—In accordance with the wish which you expressed when you were in Paris, I send you the following remarks, respecting the oil that is burnt through France.

" It is known by the name of Colza oil, *Huile de Colza*, and is extracted from the seeds of the *Brassica Arvensis*, or *Campestris*, a species of cabbage.

" The Colza is very much cultivated throughout France and the Netherlands, on account of its various and useful qualities. In the north of France, and particularly in the environs of Lisle, the greatest possible attention is paid by the farmers to its production. The seed is sown during the month of July, as we sow our seed for the purpose of procuring cabbage plants. They are transplanted in the month of September; a cloudy day being preferred. A man goes first making holes in the earth, at a distance of about twelve inches apart; he is immediately followed by a child, who puts into each hole a single plant; a third person finishes the operation, by closing the earth around the plants with a hoe. When the seed becomes ripe, which generally happens in July of the following year, the plant is cut, tied in small bundles, and put under a shed, or any covered and airy place, to dry. The seeds are then beaten out, and cleaned in the manner of wheat or other grain; and are then treated in the usual manner, for the extraction of their oil. The oil may be used directly it comes from the press, with potash, for the fabrication of soft soap; but if intended for burning, it is necessary that it should undergo a preparation, in order to separate its mucilage and colouring matter, which prevent its ready

* From the *Journal of the Franklin Institute*.

combustion. We are indebted to M. Thenard, for the method of purifying it. It consists, in mixing two parts of concentrated sulphuric acid, with a hundred parts of oil, these are to be well stirred together, until the acid combines with the mucilage and colouring matter, which are gradually precipitated in flakes, of a blackish-green colour; after which, a quantity of water, equal to double that of the oil, is added; the whole is then strongly agitated, with the intention of depriving the oil of the free acid; it is then left to settle for ten days, at the end of which time, the oil which floats upon the surface of the water is drawn off into tubs, in the bottoms of which are holes filled with cotton, through which the oil filtres, when it is become perfectly pure. This method of purification is applicable to all seed oils. The oil of Colza, thus prepared, has very little odour, is of a yellowish colour, and is of a sweetish taste. It is not very soluble in alcohol. When congealed, it crystallizes in small needles, diverging from a centre."

XXXIX.—*On the Friction and Abrasion of the Surfaces of Solids.* By George Rennie, *Esq. F.R.S.**

The paper now offered to the consideration of the Royal Society, comprises the results of part of a series of experiments undertaken in the yeer 1825, with a view to determine the measure of the retardation of bodies in motion, when affected by the attrition of their surfaces, and by mediums of different densities.

From the attention that has hitherto been paid to this important branch of mechanical science, and from the many elaborate dissertations and experiments that have appeared at different periods, it would naturally be concluded that the subject had been so fully elucidated, as to admit of little, if any, further investigation. But the diversity of opinions still prevalent among philosophers, and

* From the Philosophical Transactions.

the difficulty of reducing to a satisfactory state the doctrines already advanced, incline me to the opinion, that the subject is as yet but imperfectly understood. This may be attributed, in a great degree, to the very defective state of our knowledge of the properties of materials, and the difficulty, or rather the impossibility, of subjecting them to geometrical mensuration. The science of mechanics considers forces as reduced to the simple questions of mathematical analysis, without regard to the properties of matter or the phenomena incident thereto: but in rendering forces sensible, we are necessarily compelled to make use of agents, or intermediate bodies, termed machines, the employment of which in transmitting motion, in modifying its action, or in restoring the equilibrium between forces of different intensities, constitutes the object of every mechanical operation. The solution of this question, therefore, involves the conditions of equilibrium, both of simple and compound machines; the transmission of motion under different circumstances; the construction and combination of the different parts of machines, and the properties of the materials of which these parts are composed.

On a former occasion, an attempt was made to develop some of the properties of solid bodies in resisting the action of a disruptive force*, the measure of which was represented by the sum and qualities of the particles displaced. The connexion may be traced, in the present inquiry, which relates principally to the resistance arising from the displacement or rupture of the superficial asperities of bodies in motion, when brought into contact by extreme pressure, and is analogous to the cohesive state of a body, acted upon by opposite but contrary forces. But the cases investigated by experimentalists, have seldom been carried to the extent necessary to produce a disrupture of the prominences, being generally confined to the definition of friction as designated by writers on mechanics, to be the force expended

* Experiments on the Strength of Materials. Philosophical Transactions, 1817.

in raising continually the surface of pressure by an oblique action, the surfaces being represented by a series of inclined planes acting against each other in alternate succession. The measure of friction, therefore, being supposed to depend upon the angles of the prominences, and the elementary structure of the bodies, the effect of polishing could only be to diminish those prominences, without altering their curvature or inflections. The expense of force, therefore, ought still to remain the same in both cases*. In this hypothesis it is reasonable to concur, experiment proving that the amount of friction bears immediate reference to the elementary structure of bodies; and although the doctrine of inclined planes admits of a ready comprehension of the causes of this kind of resistance under certain circumstances, a very slight investigation of the nature of the bodies themselves, will exhibit their asperities and concavities and the nature of the surfaces of which fibrous, soft, or hard bodies are composed. To surmount, bend, or detach these asperities, under the circumstances of pressure, area, and velocity, demands a proportionate exertion of force; and it is by the determination of this force under all cases, that we can only arrive at an estimation of the performance of machines.

The nature of friction has excited the attention of most of the writers on mechanics, from the period of the first two dissertations of Amontons in the year 1699, down to the elaborate researches of Coulomb and Vince, in 1779 and 1784. Amontons was the first that attempted to develop and reduce theory to calculation. He affirmed that friction was not augmented by an increase of surface, but only by an increase of pressure†; and in a subsequent paper, illustrated by some experiments on wood and metals, pressed by springs of known intensities, he drew similar conclusions, with the addition that friction was one-third of the pressure, and that the amount was the same both with

* Leslie's Experimental Philosophy.

† *Sur la force des Hommes et des Chevaux, et de la Resistance causà dans les Machines.*

wood and metals, when unguents were interposed. He likewise concluded, that friction increased or diminished with the velocity, and varied in the ratio of the weight and pressure of the rubbing parts, and the times and velocities of their motions. These hypotheses were adopted more or less by most of the philosophers after Amontons, but particularly by De la Hire*, who satisfied himself by several experiments of the truth of Amonton's conclusions; but they were questioned by Lambert, although without the test of experiment. Parent suggested an investigation of the subject, in his proposition of the spheres, and by determining the angle of equilibrium at which a body resting on an inclined plane commenced sliding. And the celebrated Euler, in a very elaborate paper†, conceived it to depend upon the greater or less approximation of the asperities of the surfaces brought into contact by pressure, the resistance to which he allows to be one-third of the pressure, the same as Amontons. Of the effect of velocities, he was, however, uncertain; but observed that when a body begins to descend an inclined plane, the friction of the body will be to its weight or pressure upon the plane, as the sine of the plane's elevation to its cosine, &c. But when the body is in motion, the friction is diminished one-half. Muschenbroek and others maintained that friction increased with the surface; and Bossut distinguished it into two kinds; the first being generated by the gliding, and the second by the rolling, of the surface of a body over another: and remarked, that it was effected by time, but that it neither followed the ratio of the pressure nor the mass. Brisson‡ attempted to construct a table of co-efficients, to denote the value of the friction of different substances; but they are inapplicable to practical purposes, for want of proper experiments. Desaguliers considered the nature of friction with a good deal of attention, but principally with reference to the rigidity of cords. He, however, quotes the experi-

* *Memoires de l' Academie des Sciences.*
† *Memoires de l' Academie des Sciences.*
‡ *Brisson, Traité de Physique.*

ments of Camus, as best calculated to illustrate the subject; nevertheless, they were made on too small a scale to derive any satisfactory conclusions. Scober and Meister coincided with Muschenbroek in the opinion, that the spaces were as the squares of the times, in the case of a body uniformly accelerated. The opinions of many other eminent philosophers, such as Leibnitz, Varignon, Leupold, Bulfinger, Daniel Bernoulli, Ferguson, Rondelet, Gregory, Leslie, Young, Olivier*, &c., might be quoted. But it is to Coulumb principally that we are indebted for the knowledge we possess of this kind of resistance.

In the year 1779, the Academy of Sciences, at Paris, being desirous of rendering the laws of friction, and the effects resulting from the rigidity of cords, applicable to machines,—Coulumb undertook, in the arsenal at Rochfort, a very extensive series of experiments, which he afterwards published in 1781, under the title of "*Théorié des Machines simples, en ayant égard au Frottement de leurs Parties, et à la Roideur des Cordages*†." The memoir is divided into two parts The first treats of the friction of surfaces gliding over each other; and the second enters into an examination of the rigidity of cords, and the friction of the rotary movements of axles. Coulumb commences his work by examining the friction of plane surfaces gliding over each other, distinguishing it into two kinds, the first resulting from time, and the second from velocity. The first may depend on four different causes, viz.

1st. The nature of the bodies in contact.

2nd. The extent of surface.

3d. The pressure on the surface.

4th. The time the surfaces have been in contact. And he even adds a

5th. The state of the atmosphere; which he, however, thinks may have little influence.

The case of bodies gliding over each other with a certain

* *Sur les diverses Espèces de Frottements,* &c. (not published).

† *Memoires des Savans Etrangers, tome* 163. *et* 333.

velocity, he considered to be referable to the first three causes, besides the velocity of the planes in contact.

With regard to the physical cause of friction, he coincides with the opinions of Amontons and others, that it arises from the entangling of the asperities, which can only be disengaged by bending or breaking. These experiments led to some important results, viz.

1st. That the friction of wood on wood, without unguents, was in proportion to the pressure, which attained its maximum in a few minutes after repose.

2nd. That the effects of velocities were similar; but the intensities were much less to keep the body in motion, than to detach it from a state of rest, oftentimes in the ratio of 22 : 95.

3d. That in the case of the metals, the results were likewise similar; but the intensity was the same, whether to disturb or maintain the motion of the body.

4th. That with heterogeneous surfaces, such as those of woods and metals, gliding over each other, the intensity did not attain its limit sometimes for days.

In general, however, with woods and metals, without unguents, velocities were found to have very little influence in augmenting friction, except under peculiar circumstances.

The treatise of Coulumb is illustrated by a great variety of interesting experiments, and forms the most valuable work we possess on the subject.

In the year 1784, Dr. Vince endeavoured, by some very ingenious experiments, to determine the law of retardation, together with the quantity and the effect of surface on friction. The results were, that the friction of hard bodies in motion, was a uniformly retarding force, but not so with cloth and woollen, which were found in all cases to produce an increase of retardation with an increase of velocity.

That when the surface varied from 1.61 : 1 to 10.06 : 1, the smallest surface gave the least friction; and, finally, that friction was greatly influenced by cohesion.

Dr. Vince's conclusions regarding the laws of retardation,

were partly confirmed by the late ingenious Mr. Southern, of the Soho, who, in a letter to Dr. Vince, in 1801, communicated the results of several experiments on the surfaces of the spindles of grindstones, moving with great velocities; when it was found that with the rubbing surfaces moving at the rate of four feet per second over a length of surface of one thousand feet, the resistance arising from the friction of three thousand seven hundred pounds of matter only amounted to one-fortieth of the weight.

In the year 1786, and subsequently, the late Mr. Rennie made several experiments on the friction of heavy machinery. The results varied under different circumstances; but it appeared that an augmentation of resistance took place in proportion to the quantity of machinery put into action. In one instance, in the ratio of one to five, when it absorbed from one-fifth to one-tenth of the power expended.

This anomaly, as compared with the ratio of surfaces in the present experiments, can only be accounted for from the irregularity of the movements, and the difficulty of producing simultaneous actions, in complicated machinery; the more especially as the results were affected by contingencies which could not be properly estimated; some of the elements on which the deduction is founded not being stated. The resistance was, likewise, increased by reversing the direction of motion. The velocities being very moderate, and hardly exceeding one hundred and twenty feet a minute, appeared to have had no influence; but the experiments related principally to the resistances produced by different kinds of machinery. The experiments of M. Boistard* on the gliding of stones, with a view to develop the equilibrium of arches, led him to conclude that the relation of the friction to the pressure was constant; that asperity of surface did not alter its value, which generally amounted to four-fifths of the pressure.

* *Recueil d' Experiences et d' Observations, &c. sur le Pont de Nemours.*

From similar experiments M. Rondelet concluded*,

1st. That the rougher the surface of stones, the greater the power required to move them.

2nd. That the greater the insistent weight, the greater the resistance; but as the inequalities are apt to be broken, the maximum force required to overcome the friction, ought to be equal to produce that effect, whatever be the weight of the stone.

3d. That this force ought rather to be in the ratio of the hardness of the stone, than of its weight.

4th. The amount of friction varied from one-half to one-third of the insistent weight.

5th. The angle of equilibrium of similar stones was about thirty degrees. And,

6th. Finally, extent of surface did not alter its value.

The experiments of Morisot on the grinding and polishing of stones, and of Mamel and Pasley on the pressure and equilibrium of earths, present some interesting results; but it is only recently that our knowledge of the subject has been materially enlarged.

The agitation of the canal and rail-road question in the years 1824 and 1825, and the invention, or rather revival, of a mode of applying steam in lieu of animals to carriages on rail-roads, led to the most extravagant conclusions: and although the doctrines of Coulomb and Vince, relative to the equality of resistances under different velocities, have been still farther confirmed by the experiments of many able persons in this country, such as Chapman, Grimshaw, Wood, Tredgold, Palmer, Roberts, and others, and much valuable information elicited; our progress in the science has been but slow and unsatisfactory. Sensible of these defects, and being unable to profit by the valuable treatises subsequently published, it occurred to me that a series of experiments founded on the omissions of former writers, would be extremely desirable.

* *L'Art de Batir*, tome III. 1808.

The present series of experiments relates to the friction of attrition. This branch of science comprehends the resistance occasioned by solid bodies, such as ice, cloth, paper, leather, wood, stones, metals, &c., gliding over each other simply, or by the intervention of semi-fluids or unguents, such as oil, tallow, &c.

The object has likewise been to determine the powers to resist abrasion under the circumstances of surface, pressure, and velocity. Examples have been sought,

1st. From ice, by the resistance of its surface to sledges, skates, &c.

2nd. From cloth, by its remarkable properties of resistance in opposition to the law observed by solids.

3rd. From leather, by its great utility in the pistons of pumps, &c.

4th. From wood, in its application to pile-driving, carpentry, launching of ships, &c.

5th. From stones, as relating to the equilibrium of arches and buildings. And,

6th. From metals, from their universal application to machinery; but more particularly to wheel carriages and rail and other roads, on which a great many experiments have been made.

Experiments on a great scale, however, frequently involve so many contradictions, from the difficulty of obtaining the necessary elements, that I have deemed it preferable to offer the present series, as comprehending in a greater degree most of the cases in question, and affording a more systematic view of the nature of the investigation.

(*To be continued.*)

XL.—*On Improved Melting-Pots, for Iron, Steel, Brass, &c. By Mr.* Charles Sydney Smith *.

It appeared in evidence before the Committee of Chemistry, that Mr. Smith's pots were made while he was in the service of a manufacturer of metallic axle-trees†, who therefore had occasion for a considerable quantity of metal castings. The fusions were performed in earthen pots, each of which was required to stand an entire day's work without cracking, or becoming leaky, by the formation of small holes, called pin-holes.

The failure of a pot is a serious inconvenience, both on account of the loss of time, fuel and metal, as well as of the interruption which it creates. Great variations are observable in the duration of pots from different makers, and even in those by the same maker; arising not so much from difference in the materials employed, as from a difference of skill or care in mixing of the ingredients, and in the other parts of the manipulation. Whenever a bubble of air is left in the clay after being tempered, a pin-hole in the pot made of such clay will be the common result, for the pressure of the melted metal will probably force a way through this weak part.

In order to submit the pots made by Mr. Smith to a very severe trial, one was kept constantly at work for two days and the intervening night; during which time it received twenty-three charges of seventy pounds each, of cast-iron. Another pot was worked for three successive days, the fire being raked at night, in order to prevent it from cooling; under this management it received eighteen charges of cast-iron, of the same weight as the former.

Neither of the pots had cracked or leaked in the least, but were now become unserviceable, from the lip having

* From vol. XLVII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, Adelphi. The Society presented the sum of Twenty Pounds to Mr. Smith.

† Mr. William Mason, patent axle-tree maker, Margaret Street, Cavendish Square, whose superior melting-pots, have been frequently mentioned in our work.—Editor.

been worn down into the side, in consequence of the necessity of knocking away the scoriæ after each fusion, which could not be done without breaking down a little of the lip.

The pots made by Mr. Smith are composed of the following ingredients: Stourbridge clay, coke, and plumbago, or black-lead, as it is usually called.

Stourbridge clay comes to market either ground or in lumps; the price charged for each is the same, and therefore the latter is to be preferred, as being less mixed with impurities. A convenient quantity of this clay is to be put on a sieve one-fourth of an inch in the mesh, and is to be carefully hand-picked, all pebbles and other impurities being thrown aside; it is then sifted on a board, and put into a bin. Those pieces which will not pass through are transferred to an iron mortar, having a spring-pestle, in which mortar they are pounded till they are fine enough to pass through a finer sieve, the meshes of which are one-eighth of an inch wide. This fine clay is put into a barrel by itself.

The coke is thus prepared: the masses, in the state in which they come out of the oven (for gas coke is of inferior quality), have their tops and bottoms broken off; the middle parts only which are of an uniform firm texture, being reserved for use. The coke is now to be pounded, taking care so to manage by moderating the blow of the pestle, that as little dust as possible be made. When duly pounded, it is to be thrown on the finer sieve, and all that passes through it is to be rejected; it is then to be transferred to the coarse sieve, and what passes through is now of a proper size *.

The plumbago is Mexican, and is to be reduced to a very fine powder.

The board called the walking board, on which the mix-

* We believe that bits of coke, only small enough to pass through the meshes of a sieve one-fourth of an inch wide, would be too coarse; most probably the finer sieve would be proper.—EDITOR.

ing and tempering of the ingredients is performed, is six feet square, having cross-pieces on its underside, to raise it about two inches from the ground. The process commences by mixing on the coarse sieve eight quarts of clay and five quarts of coke, and sifting them together on the walking board; here they are to be still farther mixed by hand, till the mass appearing uniform, it is to be collected in a heap, clean water is then to be added and stirred in, so as to make the mixture of the consistence of mortar. One treader (or, for expedition sake, two) is then to get on the board, and is to tread the mass well with his naked feet, working it chiefly with the heels, in a circular manner from the circumference to the centre. When well trodden it is to be turned over, or thrown with a spade, and is again to be trodden, alternating these two processes for about twenty minutes.

Then mix on the finer sieve four quarts of finely pounded plumbago, and sift a little of it over the mixture on the board; tread and throw it over, as already described; then sift on more of the fine clay and plumbago, and proceed in this manner till the ingredients are thoroughly incorporated, and the air has been all trodden out. The mixture should remain for a night in lump, and the manufacture of melting-pots from it, may begin the next morning.

The apparatus used for moulding the pots, consists of a four-legged board or bench, called a horse, for the workman to sit on, having near its fore end, two uprights mounted upon it, supporting a cross board upon their tops, through the middle of which a round hole is made, capable of receiving the stem of the plug or core. Below, and perpendicular to this hole, a socket is fixed into the bench, for the reception of a pin, that terminates the stem of the core, and tends to keep it upright and steady; the core, fixed on the top of the stem, and therefore an inch or two above the cross board, is shaped so as to form the cavity to be made in the melting-pot, and has a border at its lower part, intended to regulate the thickness of the rim of the

pot. The best dimensions for the board or bench of the horse, are, three feet six inches in length, nine inches in width, and three and a half inches in thickness: it should be raised sufficiently high to allow the workman to sit on it, with his feet resting upon the ground; and the parts where his thighs press against, should be rounded off, and curved inwards a little. The cross-board, which receives the stem of the core, should be raised six inches above the horse; and upon it is erected the square, or gauge, which may be eighteen inches high, and ten inches in the cross-arm or blade at the top of it; but, of course, varies with the sizes of the pots. The cap, which fits the core, should be made of basil, or sheepskin leather.

Every thing being ready, the core is first to be well rubbed over with plumbago, to prevent the cap from sticking to it; the cap is then to be put on the core, and a piece of the mixed materials or *walk*, as it is technically called, large enough to form the intended melting-pot, is to be cut off from the mass. A pot, capable of holding seventy pounds of cast-iron, requires sixteen and a half pounds; one for thirty-five pounds of brass, requires ten pounds. The piece is to be worked and beaten well on the walking board, and is to be carefully made into a lump, by repeatedly throwing it forcibly upon the board; after which, a cavity being previously formed in it, it is to be placed upon the top of the core. The workman then takes a flat piece of wood, four inches square, with a handle, called a *flatter*, and strikes the lump with it, beginning at its top, and bringing down the clay gradually, with his hands and the flatter, till it has reached as low as the rim or border, at the bottom of the core. During this operation, the stem of the core being occasionally grasped in one hand, and turned gently round; the clay upon it is gradually brought under the action of the flatter. Great care is to be taken during this operation, that no air gets into the clay; or, at least, if any air-bubble should appear in it, that part is to be cut out with a knife. The bottom of the pot is now to be

beaten quite flat, making it of a proper thickness, as directed by the cross-arm of the gauge; and observing that the moulded pot is not made to rise upon the core, from any clay getting between its rim, and the border of the core; for the consequence of this would be, that the bottom of the pot, though regulated by the gauge, would then be too thin, by all that rising of the pot upon the core. The workmen now dips one hand into water, and grasps or presses the pot with it, rubbing from the top to the bottom of it, whilst the other hand turns the core, and the pot upon it, round. The effect of this is to cause the pot to become of an uniform thickness all round. Finally, the pot is to be smoothened all over, as well as at the bottom; and the process of moulding upon the core is completed. The first pot of each day's work should, however, be cut in two with a knife, in order to ascertain that there are no air-holes in it, and that the tempering has been properly performed.

As a soft new made pot might get out of shape, by being handled; so the core, with the pot upon it, is therefore taken off the horse, and carried to a quiet sheltered place; and the pot being then set on its bottom, the core is raised out, leaving the leather cap within the pot, but which easily parts from the pot, with a little management. The pouring lip is then formed, by pressing the handle of a trowel from within the pot, against the fore-finger and thumb, placed outside the pot, one on each side of the part to be bulged, in order to limit the action of the pressure.

It is by no means an unnecessary precaution, to put the new made pots into a quiet place; for if they be subjected to any considerable jarring, before they get dry and hard, the pots will sink, and not be able to carry their rated charges of metal.

From twenty to thirty-six melting-pots, of an excellent quality, may thus be made in a day.

Remarks. By the EDITOR.

We are informed by Mr. Mason, that Mr. Smith originally came into his employment as a workman at the vice-bench, having been a plane maker, and, consequently, an excellent workman; but that he never had any other experience in the making of melting-pots than such as he acquired by Mr. Mason's instructions.

Mr. Mason never introduced plumbago into the composition of his superior melting-pots, either during the time when Mr. Smith was with him, nor since; he finding that Stourbridge clay, of the best quality, and coke, also of the best kind, and of a proper degree of coarseness, neither being too fine nor too coarse, are fully sufficient to form melting-pots of an excellent quality. A sieve, the meshes of which are one-eighth of an inch wide, answers well for sifting the coke; its finer parts, or the dust, having, however, been previously separated by a sieve of a still finer mesh.

XLI.—*On Emery Pastes, employed by the French Cutlers* *.

Two specimens of these emery pastes, considered by one of the most skilful cutlers of Paris, as being excellent for his use, afforded the following compositions:—

Coarse emery paste. *Emeril dur.*

Wax, mixed with a little suet .	20 parts
Colcothar	20 ditto
Emery	60 ditto

Another finer emery paste. *Emeril mou.*

Suet	18.7	or nearly	1 part
Colcothar . . .	16.7		1
Emery (*washed*, or *flour*)	64.6		4

The oxide of iron, supposing it to be in the state of col-

* From *Annal. de l'Indust. Nat. et Etrang.* and Ferussac's *Bulletin*.

cothar, may be better replaced by that in a state of crystalized oxide, which is formed by calcining a mixture of sulphate of iron and common salt *. The physical characters of the powder left after calcination, or destroying the fatty matters, seemed to accord with this supposition. In every case, however, the crystalized oxide of iron may be substituted, with advantage, for the colcothar †.

Remarks. By the EDITOR.

We have formerly given a composition of this kind; but where emery only, of various degrees of fineness, was melted with suet in the winter season, and used upon his wheels or tools, by one of the most experienced cutlers in London; no colcothar being mixed with it.

XLII.—*On the origin of the so termed Rice Paper* ‡.

THE substance commonly known as *rice paper*, and which is employed in preference to paper for certain purposes, and especially in the manufacture of artificial flowers; and which has hitherto been considered by some persons, as a product of art; and misled by the name it bears, they have thought it was prepared from rice. But, upon examining it with attention, and especially if it be held between the eye and the light, it is easy to be convinced, that it is purely a vegetable tissue, and has never been subjected to any kind of preparation; in fact, we discover that it is formed of a cellular vegetable tissue, so perfect and delicate, that it would be impossible to imitate it.

It was Dr. Livingstone who was the first to introduce this species of paper into Europe, at least in any considerable quantity; it is now about twenty-five years since he sent some of it to a Miss Jane Jock, who has enjoyed a

* As described in Vol. V. page 369.—EDITOR.
† Perhaps for razor strops.
‡ From *L'Universel*, and Ferussac's *Bulletin*.

great reputation for the beauty, and the correct imitation of nature, of the artificial flowers which she manufactured. And thus this rice paper became the fashion at that time, and was sold at most exhorbitant prices; the late Princess Charlotte of Wales, paid seventy pounds sterling, for a single bouquet of these flowers!

This paper, which Dr. Livingstone brought from China, was in the form of leaves, of about four inches square, and which were dyed of different colours; each leaf cost about six shillings. But latterly their price has been considerably reduced, and the size of the leaves augmented, so that we can actually procure such, of more than a foot long, and five inches wide, and possessing a perfect whiteness. The Chinese employed the coloured pieces to make artificial flowers, and reserved those which were of a perfect white for another purpose. This kind of paper still continues to be valued in Europe, and forms a branch of some importance in the commerce with China.

This substance is very common, and in great use in the English possessions of India. The following extract of a letter from General Hardwick, who resided a long time in these countries, leaves no doubt upon the nature of its origin:—

"I think myself happy to have it in my power, to afford you some precise information on the plant which furnishes the substance known under the name of rice paper. It is the marsh œschynomene, *æschynomene paludosa*, of Roxburgh, of the family of the leguminous plants; and you will find the figure of it in my Atlas of the plants of India. It grows abundantly in the marshy plains of Bengal, and on the borders of the vast lakes, called jeels, which exist in all the provinces between Calcutta and Hurdwar. It is a long-lived plant; its stem rarely exceeds two inches and a half in thickness; it is but of little elevation, but spreads considerably. Roxburgh, however, considered it as an annual; but it is only where it wants water that its stems dry up and die; as, where it finds the necessary

supply of water, it continues green in all parts, and pushes out new branches every season. The middle of the stem, when broken across, is found to be formed entirely of pith, which is of a dazzling whiteness, and is about half an inch in thickness; this is covered with a bark, so thin and tender, that it may be easily removed with the finger nail.

"Great quantities of this plant are carried to the bazaars of Calcutta in the fresh state. They choose the largest rods to cut into the thin lamina, which constitute the rice paper, and with which the natives make artificial flowers to decorate their idols on festival days. It is also used to make hats, by glueing together many leaves of it, so as to form it of a sufficient thickness; after which they give it what form they please, and cover it with a cloth, or a silken tissue. Thus prepared, these hats are very strong and light. Those branches of the marsh œschynomene which will not serve to make this paper, are formed into bundles, which are sold to the fishermen, and who employ them in making floats, with which they furnish those extensive lines, which they use in the lakes. The lightness of these rods, renders them exceedingly proper for this purpose.

"In order to reduce this substance into leaves, it is not cut across, but in the direction of the length of the rod, and in a spiral manner, continually turning it round; so that when it is uncoiled it forms a kind of leaf.

"I should not omit to state, that the name of this plant, in the language of Bengal, is *shola*, which is, however, commonly pronounced *sola*."

We shall terminate this notice by a description, which is given by Hooker, in a new botanical journal, intitled "Botanical Miscellanies," published in London, of a portion of a rod of the œschynomene, sent him by Dr. Livingstone, enclosed in a large leaf of the paper which the plant furnished :—"This plant is evidently herbaceous; the fragment is about four inches long; it is hollow in its centre, and has at each end a membraneous transversal diaphragm, which makes me think that the plant has knots

along it. The diameter of the rod is rather less than an inch; and the thickness of the parenchymatous substance, a little more than half an inch. This last is of the most beautiful whiteness that can be imagined. It is possible to cut this into leaves, which are not more than four inches wide, but their length may be greater. It becomes necessary to cut this so, that it may be unrolled like an ordinary roll of paper; and as we see is done in the manufacture of bottle-corks."

Remarks. By the EDITOR.

We have given an account of the knife, and another instrument employed in cutting these leaves, in our fourth volume, page 381, and to which we must refer our readers. The above particulars, however, furnish the natural history of the plant, and complete what was deficient in our former notice of it.

XLIII.—*On an Economical Process for separating Silver and Copper*.*

THE amalgam obtained at the silver works at Freyberg, leaves, when decomposed by heat, an alloy of silver, copper, and other metals; the latter used to be separated by boiling and dissolving the whole in *strong* sulphuric acid †, and then precipitating the silver. Of late, a process altogether new has been introduced. The alloy is now heated in a reverberatory furnace, exposed to air, so as to oxidize the copper; and is afterwards put into cauldrons of *lead*, and heated with *dilute* sulphuric acid, which dissolves the oxide of copper previously formed; the operations of roasting and digesting are repeated, and many precautions are requisite to obtain a good result; but these being attended to, the process *is much more economical* than the former

* From *Ann. des Mines*, and the *Franklin Journal.*
† In *platina* vessels, no doubt. EDITOR.

one. The silver is not indeed so pure, it retaining about one twenty-fifth part of copper; but this is of no consequence for ordinary uses.

XLIV. —*On the Manufacture af Scotch Whiskey.*

"It is a remarkable fact," says Major-General Stewart, in an article on the prevention of smuggling in the Highlands, inserted in the Quarterly Journal of Agriculture, "that a spirit of the best quality and flavour, has been distilled by men, with their apparatus at the side of a burn, and, perhaps, changing quickly for fear of a discovery; malting on the open heath, far up the hills, and hurrying on the whole process to avoid detection; yet, with all these disadvantages, they received the highest price in the market, for the spirit thus manufactured! The quantity might, perhaps, be less than what could be produced by a more regular process of distillation; but then the liquor was so much superior in flavour and quality, as to compensate for the deficient quantity. Several of these men have been employed, by way of experiment, in a licensed distillery on the estate of Garth, with directions to proceed in their own way, only to be regulated by the laws under the controul of an officer; yet, with the advantages of having the best utensils, the purest water, and the best fuel, they produced a spirit, quite inferior in quality and flavour, to what they produced under the shelter of a rock; and it sustained neither the same price nor character in the market.

XLV.—*On Rendering Platina Malleable, and obtaining Malleable Palladium, and the Pure Oxide of Osmium. By the late* WILLIAM HYDE WOLLASTON, *M.D. F.R.S. &c* *.

As, from long experience, I am probably better acquainted with the treatment of platina, so as to render it perfectly malleable, than any other member of this society, I will endeavour to describe, as briefly as is consistent with perspicuity, the processes which I put in practice for this purpose, during a series of years, without seeing any occasion for further improvement.

The usual means of giving chemical purity to this metal, by solution in aqua regia, and precipitation wth sal ammoniac, are known to every chemist; but I doubt whether sufficient care is usually taken to avoid dissolving the iridium contained in the ore, by due dilution of the solvent. In an account which I gave in the Philosophical Transactions for 1804, of a new metal, rhodium, contained in crude platina, I have mentioned this precaution, but omitted to state to what degree the acids should be diluted. I now, therefore, recommend, that to every measure of the strongest muriatic acid employed, there be added an equal measure of water; and moreover, that the nitric acid used, be what is called "single aquafortis;" as well for the sake of obtaing a purer result, as of economy in the purchase of nitric acid.

With regard to the proportions in which the acids are to be used, I may say, in round numbers, that muriatic acid, equivalent to 150 marble, will take 100 of crude platina; but in order to avoid waste of acid, and also to render the solution purer, there should be in the menstruum a redundance of twenty per cent. at least, of the ore. The acids should be allowed to digest three or four days, with a heat which ought gradually to be raised. The solution being then poured off, should be suffered to stand, until a

* From the *Philosophical Transactions*, for 1829, part I.

quantity of fine pulverulent ore of iridum, suspended in the liquid, has completely subsided; and should then be mixed with forty-one parts of sal ammoniac, dissolved in about five times their weight of water. The first precipitate, which will thus be obtained, will weigh about 165 parts, and will yield about sixty-six parts of pure platina.

As the mother liquor will still contain about eleven parts of platina, these, with some of the other metals yet held in solution, are to be recovered, by precipitation, from the liquid, with clean bars of iron; and the precipitate is to be re-dissolved in a proportionate quantity of aqua regia, similar in its composition to that above directed to be used. But in this case, before adding sal ammoniac, about one part, by measure, of strong muriatic acid, should be mixed with thirty-two parts, by measure, of the nitro-muriatic solution, to prevent any precipitation of palladium or lead, along with the ammonia-muriate of platina.

The yellow precipitate must be well washed, in order to free it from the various impurities, which are known to be contained in the complicated ore in question; and must ultimately be well pressed, in order to remove the last remnant of the washings. It is next to be heated, with the utmost caution, in a black-lead pot, with so low a heat, as just to expel the whole of the sal ammoniac, and to occasion the particles of platina to cohere as little as possible; for on this depends the ultimate ductility of the product.

The grey product of platina, when turned out of the crucible, if prepared with due caution, will be found slightly coherent; and must then be rubbed between the hands of the operator, in order to procure, by the gentlest means, as much as can possibly be so obtained, of a metallic powder, so fine as to pass through a fine lawn sieve. The coarser parts are then to be ground in a wooden bowl, with a wooden pestle; but on no account with any harder material, capable of burnishing the particles of platina *;

* The following experiment will prove the necessity of attending to this precaution.—If a wire of platina be divided with a sharp tool, in a slanting

since every degree of burnishing will prevent the particles from cohering in the further stage of the process. Since the whole will be required to be well washed in clean water, the operator, in the latter stages of grinding, will find his work much facilitated by the addition of water, in order to remove the finer portions, as soon as they are sufficiently reduced to be suspended in it.

Those who would view this subject scientifically, should here consider, that as platina cannot be fused by the utmost heat of our furnaces, and, consequently, cannot be freed like, other metals, from its impurities, during igneous fusion, by fluxes, nor be rendered homogenous by liquefaction; so the mechanical diffusion through water should here be made to answer, as far as may be, the purposes of melting; in allowing the earthy matters to come to the surface, by their superior lightness; and in making the solvent powers of water effect, as far as possible, the purifying powers of borax, and other fluxes, in removing soluble oxides.

By repeated washing, shaking, and decanting, the finer parts of the grey powder of platina, may be obtained as pure * as other metals are rendered by the various processes of ordinary metallurgy; and if now poured over, and allowed to subside in, a clean basin, a uniform mud or pulp will be obtained, ready for the further process of moulding.

The mould which I have used for this purpose, is a stout brass tube or barrel, six and three-quarter inches long, bored rather taper within, with a view to facilitate the ex-

direction, and being then heated to redness, be struck upon an anvil with a hammer, so as to force into contact the two newly divided surfaces, they will become firmly welded together; but if the surfaces have previously been burnished with any hard substance, the welding will be effected with very great difficulty, if at all.

When the powder of platina has been overheated in decomposing the ammonio-muriate, or has been burnished in the grinding, I have, in vain, endeavoured to give it a welding surface, by steeping it in a solution of sal ammoniac in nitric acid.

* Sulphuric acid, digested upon the grey powder of platina, thus purified, extracted less than 1-1000dth part of iron.

traction of the ingot to be formed in it; it being 1.12 inches in diameter at top; and 1.23 inches, at a quarter of an inch from the bottom, and plugged at its larger extremity with a stopper of steel, that enters the barrel to the depth of a quarter of an inch. The inside of the mould being now well greased with a little lard, and the stopper being fitted tight into the barrel, by surrounding it with blotting-paper (for the paper facilitates the extraction of the stopper, and allows the escape of water during the compression), the barrel is to be set upright in a jug of water, and is itself to be filled with that fluid. It is next to be filled quite full with the mud of platina; which, subsiding to the bottom of the water in the barrel, is sure to fill it, without cavities, and with uniformity,—a uniformity to be rendered perfect, by subsequent pressure. In order, however, to guard effectually against cavities, the barrel may be weighed after filling it, and the actual weight of its contents being thus ascertained, may be compared with that weight of platina and water which it is known by estimate that the barrel ought to contain*. A circular piece of paper first, and then one of woollen cloth, being laid upon the surface, allow the water to pass during partial compression, by the force of the hand with a wooden plug. A circular plate of copper is then placed upon the top, and thus sufficient consistency is given to the contents, to allow of the barrel being laid horizontally, in a forcible press; the construction of which will be described in the sequel.

After compression, which is to be carried to the utmost

* From the mean weight of the ingots obtained in previous operations, it is known that the barrel described in the text, ought to contain 16 ounces troy, of dry platina powder.

The weight of the contents of the barrel $= 16$ ounces $\times \frac{\text{sp. grav. of platina} - 1}{\text{sp. grav. of platina}} +$ the weight of a cubic inch of water $\times$ capacity of the barrel, in cubic inches $=$ 16 ounces $\times \frac{20.25}{21.25} + \cdot 526$ ounces $\times 7.05 = 18.9575$ ounces troy. Should the contents of the barrel weigh materially less than this estimated weight, there must be a want of uniformity in the disposition of the powder within the barrel.

limit possible, the stopper at the extremity of the mould being taken out, the mass of platina will easily be removed, owing to the conical form of the barrel; and being now so hard and firm, that it may be handled without danger of breaking, it is to be placed upon a charcoal fire, and there heat it to redness, in order to drive off moisture, burn off grease, and give to it a firmer degree of cohesion.

The mass of platina is next to be heated in a wind-furnace; and for this purpose it is to be raised upon an earthen stand, about two inches and a half above the grate of the furnace, the stand being strewn over with a layer of quartzose sand, on which the mass is to be placed, standing upright upon one of its ends. It is then to be covered with an inverted cylindrical pot, formed of the most refractory crucible ware, resting at its open end upon the layer of sand; and care is to be taken, that the sides of the pot do not touch the mass of platina.

To prevent the blistering of the platina by the heat, which is the usual defect of this metal, in its manufactured state, it is essential to expose the mass to the most intense heat that a wind-furnace can be made to afford, more intense than the platina can well be required to bear, under any subsequent treatment; so that all impurities may be totally driven off, which any lower temperature might otherwise render volatile. This furnace is to be fed with Staffordshire coke, and the action of the fire is to be continued for about twenty minutes from the time of lighting it, a breathing heat being maintained during the last four or five minutes.

The mass of platina is now to be removed from the furnace, and being placed upright upon an anvil, is to be struck, while hot, on the top, with a heavy hammer, so as at one heating effectually to close the metal. If in this process of forging, the cylinder should become bent, it should on no account be hammered on the side, by which treatment it would be cracked irremediably; but must be straightened by blows upon the extremities, desterously

directed, so as to reduce to a straight line the parts which project. The work of the operation is now so far complete, that the ingot of platina may be reduced, by the processes of heating and forging, like that of any other metal, to any form that may be required.

(To be continued.)

XLVI.—*On Enamel Paintings executed upon Stone.* By M. MORTELEQUE*.

THE application of enamel painting upon the species of larva termed *volvic*, is a new service which the sciences and the useful arts have rendered to the fine arts. Since the ingenious processes employed at the church of St. Genevieve, in Paris, under the direction of M.M. Thenard and D'Arcet, the preservation of the master-pieces in painting, executed on the interior of these edifices, has been insured; but it yet remained to discover the means of guarding against the inclemency of the weather, so that painting might also be employed in their exterior decoration. The beauty of the paintings executed in enamel, and their great durability, render them eminently proper for this purpose, had not the nature of the substances, upon which they had hitherto been applied, opposed this use of them; but the shrinkings and changes of form, which metals and porcelain experience in the fire, greatly restricted the dimensions which could be given to enamel pictures.

It therefore became a matter of high importance, to discover a substance which should not be subject to the above inconveniences, and upon which enamel could be applied with facility.

This problem is now resolved in a most satisfactory manner, by the employment of this stone from Volvic, which endures a very elevated temperature, without experiencing

* From De Moleon's *Recueil Industriel*.

any alteration; and which may also be obtained in extended surfaces, at little cost. It is principally to M. the Count de Chabrol, whose zeal contributes to the progress of all the fine arts, that we are indebted for this fortunate result; but it was M. Mortelèque, who applied with great skill, and a rare talent, the indications afforded him by M. the prefect of the Seine.

M. Mortelèque placed in the exhibition of 1827, a picture, representing the head of an old man; and which, although it abounded with the imperfections inseparable from a first attempt, yet it presented important results; and a landscape, twenty-one inches high, and sixteen wide, which this able artist executed, after a sketch in sepia, by M. Baltard, belonging to M. the Count de Chabrol, gave birth to the most brilliant hopes. These were subsequently realized in the most complete manner, by the execution of an altar-piece, intended for the church of St. Elizabeth, which M. the Count de Chabrol entrusted to M. Abel, de Pujol, and which was exhibited in the *salle d' Angoulême*, at the *Hotel de Ville*.

It is composed of three medallions, surrounded by ornaments, and the subjects are, Faith, Hope, and Charity, represented by three female busts, of the size of life. M. Abel de Pujol was directed by M. Mortelèque, in the employment of the requisite colours, and he made an excellent use of them; the flesh and the draperies possess a high degree of truth, and the head of Hope is especially remarkable for the purity of the design, and the freshness of the colours; he has, from these circumstances, given new proofs of his fine talents.

The paintings upon the Volvic stones, are made with colours analogous to those employed upon porcelain. The changes which it was necessary to make in their preparation, were directed with complete success by M. Mortelèque; but they acquired a great degree of lustre by a double burning; before receiving which, they wanted that brilliancy of varnished pictures, which produces so fine an effect.

In the first experiments undertaken by M. Mortelèque, the surfaces of the stones presented many asperities, which could scarcely be made to disappear, and caused the inconvenience of applyiug two successive coats of enamel, and also produced surfaces resembling those of oil-cloths, prepared for pictures.

The discovery of M. Mortelèque opens a vast field to painting, as applied to the external decoration of monuments; and affords the possibility of making tablets of great dimensions, which are unalterable; and whose hardness equals, and even surpasses, that of mosaics; as these last are, in time, attacked by the action of the air; whereas the Volvic stone is neither altered by fire nor water; and there is no doubt, that the effect of shocks may be easily guarded against, by giving to the plates of stone, intended for painting upon, a sufficient thickness. It may likewise be used to save expense in the marbles, and other ornaments, which are necessary in the decoration and embellishment of our public and private edifices.

The Volvic stone is granulated, and has a grey colour; it acquires a great degree of hardness when exposed to the air, and is generally considered as a volcanic product.

It is procured in the neighbourhood of Volvic, a village near Clermont, in the department of Puy de Dome, of which M. the Count Chabrol, of Volvic, prefect of the Seine, possesses the proprietorship; and where he has founded a school for architecture, in which are taught drawing, stone-cutting, and the elements of architecture, to the persons employed in working the quarries. It is fortunate that the name of Volvic belongs to one who has made useful discoveries in the arts, and whose name is dear to artists; this administrator is an ancient *élève* of the Polytechnic school, and was for a long time illustrious for the career which he pursued; and he will leave a name in the capital, which its monuments will often recal to remembrance, many of them being constructed by his orders; and nearly all of them were either restored or embellished by him.

XLV.—*On the Manufacture of Carmine**.

The manufacture of carmine, was, formerly, considerably limited; but since the discovery of its solution in ammonia, it is much employed in forming superfine red ink, in the manufacture of artificial flowers, in silk-dyeing, &c., and has, consequently, become an article of considerable demand.

We know many processes for preparing carmine: we shall now describe several, and arrange them in such a manner, as that the theory of their preparation, and their relative value, may be readily apprehended.

Carmine is the richest and purest colouring matter of cochineal, and may be separated by different means, easily understood. It is evident that the cochineal contains divers colouring materials, all capable of being subjected to the action of acids, and either forming matters which are but little soluble in water, as with insoluble bases they will form insoluble salts; or, on the other hand, with potash, soda, or ammonia, we shall obtain all the colouring matters, combined with such bases as we shall have employed. If we now add a quantity of acid, but insufficient to set all the colouring matters at liberty, the less soluble of them will necessarily be precipitated singly, or nearly so.

This explanation will be sufficient to enable any one to comprehend the manufacture of carmine; in practice, the cochineal is generally boiled, either with the carbonates of potash or soda; and the solution then precipitated either by means of a weak acid, or an acid salt. When the quantity of these bodies is not too great, the carmine will precipitate in the pure state presently; but if the precipitate be in the state of a finely divided powder, it is only by repose that it can deposit itself; and this will require a certain number of days, according to circumstances. In order, however, to expedite the process, they are in the habit of

* From the *Ann. de l'Industrie*, and Ferussac's *Bulletin*.

treating the liquid containing the matters to be precipitated with the whites of eggs, or isinglass, as in the usual modes of clarifying. Either of these two substances, on coagulating, seizes the carmine, and forms combinations therewith, more or less clotted, and which deposit themselves in a few minutes.

These preliminary observations, will suffice for the understanding of the processes, which we shall now proceed to describe; and the object of all which is to separate the carmine from the other colouring matters, which the cochineal contains.

German Carmine.—The process followed in Germany, in manufacturing carmine, consists in boiling six pints of river water, and two ounces of cochineal, in powder, in a copper basin. After having boiled for six minutes, they add sixty grains of powdered alum, and then boil them again for three minutes. The basin is then removed from the fire, and the liquid drawn off with a syphon; this is then passed through a silken sieve, and placed in several earthenware or porcelain vessels, here it is left at rest for three days; it is then again decanted, and placed in other vessels, and where it must again remain for three days. The deposits which are formed, must then be placed to dry in the shade; the first contain carmine of the first quality; but the others are inferior.

The cochineal is here boiled without the addition of any alkali; but a small quantity of ammonia is always formed, which serves to dissolve part of the colouring matter; but the quantity of the ammonia is variable, and often too weak.

As neither the whites of eggs, nor isinglass, are used in this process; so it is clear, that these substances are not necessary to the formation of carmine; indeed, they only serve, as we have above stated, to collect it more rapidly.

As we only separate, by means of a sieve, the carmine from the powdered cochineal, before it is coagulated, and whilst it is held in suspension in the liquid, and as it always

requires three days for it to deposit the carmine, so it is evident that the precipitate must be exceedingly light.

This process may answer for the artist, who practises it for his own use; but it would be absurd to employ it in the large way.

Carmine made by using the Salt of Sorrel, termed, "the Superfine Carmine of Madame Cenette, of Amsterdam.—We commence by boiling six buckets of river water in a copper basin; and at the moment when the ebullition begins, we add two pounds of Mexican cochineal, finely powdered. We suffer it to boil two hours, at the end of which time, we add three ounces of pure nitre, and a moment afterwards, four ounces of salt of sorrel, and suffer the whole to boil for ten minutes. This done, we remove the basin from the fire, and leave it at rest for four hours; we then draw off the supernatant liquid from the dregs, with a syphon, and deposit it in glazed earthen vessels, where it must remain at rest for three weeks; if any mouldiness should form, at the end of a certain time, it must be removed with a sponge. The water must be drawn off from the vessels with a syphon, and which should be plunged to the bottoms of the vessels, as the carmine appears to adhere thereto. This carmine must be dried in the shade; it is very beautiful, and of such a lustre as to fatigue the eye.

We do not see the use of the nitre; it may, possibly, be an error of the copyist, for *natron*. The quantity of salt of sorrel also appears enormous; for the rest, the tedious delay of this process, gives room for similar observations with the last; as the decantation is made at the end of four hours, but without the carmine depositing itself, and which it requires three weeks to effect.

(*To be continued*)

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since January 23, 1830.

To George Vaughan, of No. 10, Cleveland-street, Mile-end-road, in the parish of Mile-end, Old-town, in the county of Middlesex, engineer; for a machine or pump, for raising water or other fluids. Dated January 23, 1830.—To be specified in two months.

To John Yates, of Hyde, in the county of Chester, calico printer; for a method or process of giving a metallic surface to cotton, silk, linen, and other fabrics. Dated January 26, 1830.—In six months.

To George Stocker, and Alexander Stocker, both of the parish of Yeovil, in the county of Somerset, gunsmiths; for a cock for drawing liquor from casks, which produces a stop, superior to that which is effected by common cocks, and will continue in use for a onger period of time. Dated January 26, 1830.—In two months.

To John Arnold, of Sheffield, in the county of York, powder flask maker; for an improved spring latch, or fastener for doors. Dated January 26, 1830.—In two months.

To George Frederick Johnson, of Canterbury, in the county of Kent, Tunbridge ware manufacturer; for a machine or apparatus, which is intended as a substitute for drags for carriage wheels, and other purposes. Dated January 26, 1830.—In six months.

To Thomas Bulkeley, of Richmond, in the county of Surry, doctor of physic; for a method of making or manufacturing candles. Dated January 26, 1830.—In six months.

To James Cobbing, of Bury St. Edmonds, cordwainer; for certain improvements on skates. Dated January 1826.—In six months.

To Samuel Wright, of Shelton, in the Staffordshire potteries; for a manufacture of ornamental tiles, bricks, and quarries for

floors, pavements, and other purposes. Dated January 26, 1830. —In six months.

To Robert Bush, of Leeds, in the county of York, gentleman; who in consequence of a communication made to him by a certain foreigner residing abroad, is in possession of certain improvements in the apparatus used for distilling and rectifying. Dated January 26, 1830.—In six months.

To John Revere, of New York, in the United States of America, but now residing in the parish of Saint James, Westminster, M.D.; for a new alloy or compound metal, applicable to the sheathing of ships, and various other useful purposes. Dated January 28, 1830. —In six months.

To Joshua Lambert, of Liverpool-street, in the city of London, esquire; for an improvement in the process of making iron, applicable at the smelting of the ore, and at various subsequent states of the process up to the completion of the rods or bars, and a new process for the improving of the quality of inferior iron. Dated February 4, 1830.—In two months.

To George Pocock, of Bristol, gentleman; for improvements in making or constructing globes for astronomical, geographical, and other purposes. Dated February 4, 1830.—In two months.

To John Gray, of Beaumorris, in the county of Anglesea, gentleman; for a new and improved method of preparing and putting on copper sheathing for shipping. Dated February 4, 1830.—In two months.

To Charles Taverner Miller, of Piccadilly, in the county of Middlesex, wax chandler; for certain improvements in making or manufacturing candles. Dated February 4, 1830.—In six months.

To Joseph Clisild Daniell, of Limpley Stoke, in the parish of Bradford, in the county of Wilts, clothier; for certain improvements in the machinery applicable to the manufacturing of woollen cloths. Dated February 6, 1830.—In six months.

To Melvil Wilson, of Warnford-court, Throgmorton-street, in the city of London, merchant; who in consequence of a communication made to him by a certain foreigner residing abroad, is in possession of an improved method of preparing and cleansing paddy, or rough rice. Dated February 6, 1830.—In six months.

To Thomas Robinson Williams, of Nelson-square, Blackfriars-road, in the county of Surrey, esquire; for improvements in power-looms, applicable to the weaving of wire, and other materials. Dated February 6, 1830.—In six months.

To Edward Cowper, of Streatham-place, in the county of Surrey, gentleman; who in consepuence of a communication made to him by a certain foreigner residing abroad, is in possession of certain improvements in the manufacture of gas. Dated February 12, 1830.—In six months.

To John Frederick Smith, of Dunstan-hall, Chesterfield, in the county of Derby, esquire; for certain improvements in preparing or finishing piece goods, made from wool, silk, or other fibrous materials. Dated February 12, 1830.—In six months.

To Joseph Marie Ursule La Rigandell Du Buisson, of Fenchurch-street, in the city of London, merchant; who in consequence of a communication made to him, by a certain foreigner residing abroad, is in possession of a new method of extracting, for the purpose of dyeing, the colours from dye-woods, and other substances used by dyers. Dated February 12, 1830.—In two months.

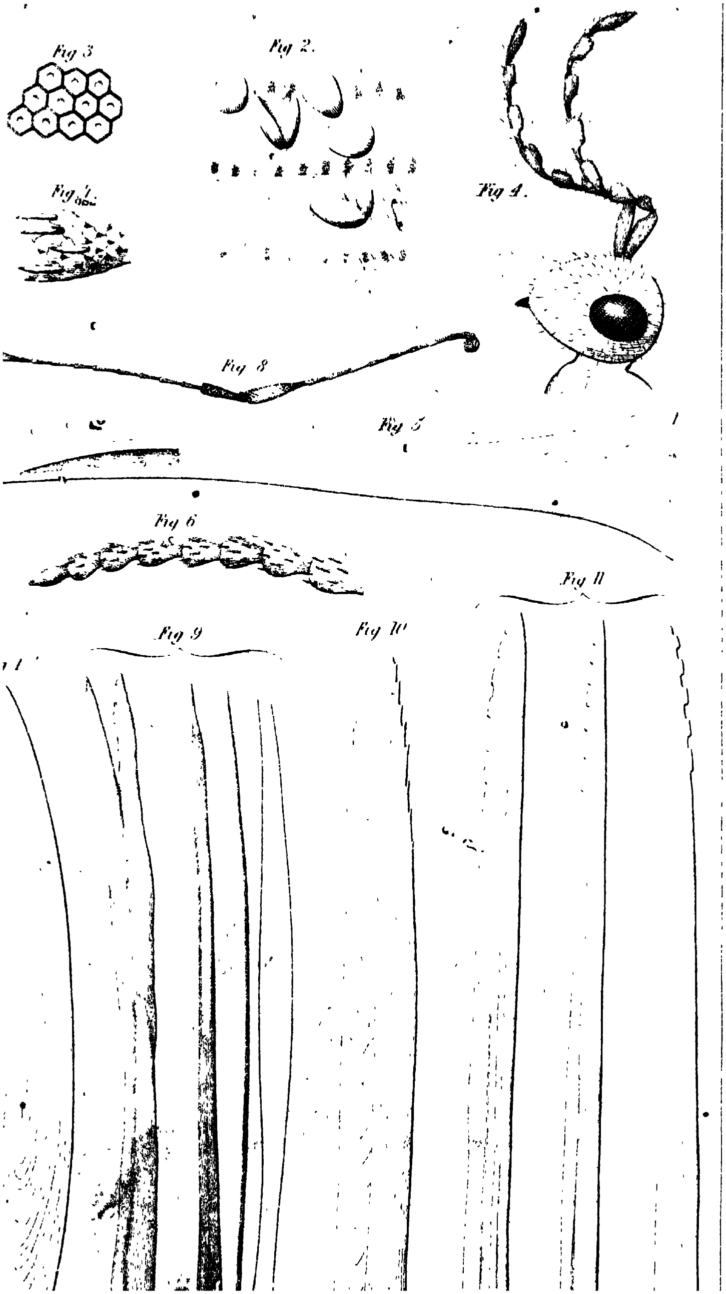
Fig 3
Fig 2.
Fig 1.
Fig 4.
Fig 8
Fig 5
Fig 6
Fig 11
Fig 9
Fig 10

GILL'S
TECHNOLOGICAL & MICROSCOPIC REPOSITORY.

XLVIII.—*On the Microscope. By* THOMAS CARPENTER, *Esq. With Remarks and Additions. By the* EDITOR.

WITH A PLATE.

(*Continued from page* 142.)

DEAR SIR, *London, March* 8, 1830.

I HEREWITH send you a few objects on a much larger scale than those I have before submitted to your inspection. These are more properly adapted for exhibiting under the lantern, lucernal, and solar microscopes; yet, under your compound or single microscopes, you will find much to admire, in the various characters and markings they possess; but on viewing them under the instruments first mentioned, and using a moderate power object-glass, the effect produced will be strikingly grand. In four of the glass sliders are the wing-cases, wings, and hind legs of the *blatta*, or cock-roach; in another slider are the four wings of a species of *osmylus;* and between the sixth slider you will find scales from the sea perch, the river perch, the flying fish, and the dolphin. In exhibiting these objects under your Adams's lucernal or lantern microscopes, you may thus make choice of suitable ones for those instruments; as I have always found that those objects which are strongly marked are the best adapted for them; as those with delicate lines or characters do not show to any advantage under them.

With the above you will also receive several other ob-

jects, adapted for viewing under your Varley's single microscope, which I have selected from my cabinet.

In the month of October, 1821, I was walking by the side of the New River, near Tottenham, and observed several large fresh water muscles, lying in the mud, which had been thrown out of the water. On my looking into one of them, I observed it was filled with thousands of exceedingly minute young ones; these were enclosed within large membranes, which completely filled the parent fish, from one end to the other of its interior. I took a small portion of the mass on the point of a pin, and placing it on a slip of glass under my microscope, I was astonished at seeing in that small portion upwards of one hundred perfect muscles in a living state, opening and shutting their shells, apparently in search of food. In order to preserve them for future examination, I boiled the parent fish. A few of the young ones, with a portion of the membrane, I now send. The shells of many of them you will observe to be open, and they are very curious objects, as well as are the characters on the envelope containing them.

I also send you several species of the genus *chrysis*, or golden fly; among them you will find *c. ignita*; this may be considered one of the most beautiful of European insects. The fore part of the head is green and gold, and the hinder, azure. The thorax is likewise azured over, with a mixture of green, and it terminates at the extremity with sharp points on both sides. The abdomen is green and gold before, and of a copper red behind, imitating molten copper, highly polished. The whole insect is also dotted on its upper part, which gives it a great resplendency of colour. The antennæ are black, and the legs green, intermixed with gold. This species dwells in holes of walls, between the stones, and in the mortar that cements them; and where it nestles and performs its work. When it has prepared its nest, and previous to depositing its egg, it goes in search of a caterpillar, and will even frequently enter the nest of the wild bee, and bring from thence to its own

nest, the larva of the bee, on which it will deposit an egg; this egg soon produces a caterpillar, which immediately begins to feed on the larva of the bee, and is thus provided by its parent with food, until its change into the pupa state; it then remains in a torpid state, until its last change into the perfect fly.

I likewise send you a curious insect, whose death took place under singular circumstances. I found it in a cellar, in a cold damp situation; and, on placing it in the window, the sun's rays falling powerfully upon it, the insect appeared to be strongly convulsed, and instantly expired. With this are likewise two curculios, found on the cherry-tree, they are embellished with much delicate work on their exterior; also a small insect, *necedalis cærulea,* the colour of this insect is very fine, it is also remarkable in having extraordinary thick hinder legs compared with its size. Also several specimens of the genus *hemerobius*; the wings of these are fine transparent objects for the microscope, particularly the species *h. variegatus,* and may also be viewed as opaque objects, in which situation they will exhibit a variety of most splendid colours. Their eyes and antennæ, also are interesting objects. Several specimens of the genus *donacia* accompanying these, which you will find highly interesting objects, in the characters with which the head, thorax, and wing-cases are adorned; as also in the rich colours on every part of the insects. I likewise send you a specimen of the wild bee, singularly fortified about the head, in having a couple of strong horns on it, situated under its antennæ. Another specimen of a wild bee is also sent, *anthrophora retusa;* the middle legs of this insect are covered down to the feet with very long hairs; the proboscis is extended from its head, but not separated; but, on a piece of card, I have placed another head, with all the parts belonging to the mouth displayed and named; which you will find interesting in the examination of them. Also another wild bee, *eucera longicornis,* the long horned bee. Mr. Kirby, in speaking of

this bee, says, "A singular circumstance distinguishes the antennæ, which, to the best of my knowledge, has never before been noticed ; and which may possibly lead to the discovery of the use of these organs. Placed under a powerful magnifier, the last ten joints appear to be composed of innumerable hexagons, similar to those of which the eyes of these insects consist. If we reason from analogy, this remarkable circumstance will lead us to conjecture that the sense of which this part, so essential to insects, is the organ, may bear some relation to that conveyed by the eyes. As they are furnished with no instrument for receiving and communicating the impressions of sound, similar to the ear, that deficiency may be supplied by extraordinary means of vision. That the *stemmata* are of this description seems very probable ; and the antennæ may, in some degree, answer a similar purpose : the circumstance just mentioned furnishes a strong presumption that they do this, at least in the case of these males ; else why do they exhibit that peculiar structure which distinguishes the real eyes?" With this bee I send one of the horns, placed on a slip of card, in order that you may examine the characters on it, as described by Mr. Kirby. With these I likewise send two flies of the genus *Musca,* covered with hairs of a feathery appearance; also a cluster of eggs, laid by the large blow fly. Some exceedingly minute *cynips,* whose antennæ highly deserve examination, they being extremely delicate, and of a beautiful form. With these I send you a variety of the genus *podura,* these I found on various plants in the hedges, and they are very different from those found in cellars, which have furnished us with such exquisite test objects for our microscopes. These I now send are covered over with long hairs, and do not appear to be furnished with scales, nevertheless, they are very curious objects when viewed under the opaque speculum.

On the willow leaves you have, no doubt, often observed numerous tubercles or swellings, each of which is occasioned by a small fly piercing the leaf, and depositing an egg

within it. The sap flowing up to that part, is stopped by the puncture made in the leaf, and occasions those swellings, which form a case and food for the young gnat when excluded from the egg. After the caterpillar has fed its accustomed time, it undergoes its changes into the crysalis state, and perfect insect, within the tubercle, and eventually makes it way out. In order to ascertain this fact, I cut one of the tubercles open, and found a caterpillar within it, which I enclosed in a pill box, and in the month of October a perfect fly was produced. I have sent you the fly, and also the tubercle cut open, and in which you will perceive the exterior or cast-skin the caterpillar threw off, previous to its change into the perfect insect.

Varies flies as well as many other insects deposit their eggs in almost all the food we take into our stomachs, among other articles subject to their depredations, I found in a pot of preserves a number of larva, these I kept, and occasionally examining them, found they underwent their changes into the pupa, and afterwards into the fly, state, I have sent them to you in their various states of larva, pupa, and imago. The colours of the wings are very beautiful.

In the autumn of 1823, I made a cask of grape-wine, and put a piece of brown paper over the bung-hole, on which paper I also placed a piece of slate, to prevent wasps, flies, and other insects from getting into the wine, and on my examining the wine in the following March, I observed under the slate, and on the upper side of the brown paper, several larvæ, resembling those of the flesh fly, but not half their size; they were feeding very greedily on the liquid produced from the wine, and which had soaked through the paper. At that time I suppose they would eventually change into small flies, like those I had frequently found in vinegar, as mentioned by me in a former letter, and to prove which, I put several of the larvæ into a phial, with some of the paper saturated with wine for them to feed on, and also covered the mouth of the phial over with paper, which I perforated with a pin, in order to admit air; but

instead of flies coming forth, as I fully expected, the larvæ became pupa, and changed into a small species of beetle, of the genus *cryptophagus*, in the month of June. I send you a few of the dried larvæ, the crysalis cases, and several of the perfect insects. You will find the antennæ, the eyes, and various parts of these insects, very curious objects under the microscope.

I send you a singular species of spider; at the time I caught it, its colour was perfectly white; though it has now changed colour a little. The eyes are eight in number, but are differently situated in the head to those of most other spiders. With this you will also receive a foreign species of spider, which is covered with fine metallic scales, and what in fact is the case with most of our British hunting spiders, indeed the vast profusion of scales with which many of these species are covered, makes them very interesting objects when viewed under the opaque speculum. I also send a few specimens of *cerambyx*, the capricorn beetles. This is a very beautiful and finely variegated family of insects, consisting of upwards of five hundred species, some are of a most gigantic size, measuring near seven inches in length; the devastation they make in timber, while in the larva state, is astonishing! The larva of *cerambyx demicornis* is a native of many parts of America and the West Indian Islands, where it is in great request, like that of the palm curculio, as an article of food, being considered by the transatlantic epicures as one of the greatest delicacies in the western world. We are informed by authors of the highest respectability, that some people of fortune in the West Indies keep Negroes for the sole purpose of going into the woods in quest of these admired larvæ; and who scoop them out of the trees in which they reside. Their general length is about three inches and a half; and their thickness that of the little finger. They are commonly called by the name of *macaccos* or *macokkos*. The mode of dressing them, is first to open and wash them, and then carefully broil them over a charcoal fire.

The circumstance of the larvæ of *cerambyx violacus* attacking only such timber as has not been stripped of its bark, ought to be attended to by all persons who have any concern in this article; for the bark is a temptation not only to this, but to various other insects; and much of the injury done to timber might be prevented, if the trees were all barked as soon as they were felled. The female is furnished with a retractile tube. This she inserts between the bark and the wood, to the depth of about a quarter of an inch, and there deposits a single egg. I have displayed between two slips of glass an ovipositor from a very small species of this genus, in which you will observe numerous muscular fibres, with characters highly interesting. I likewise send you an insect of another genus, *callidium bajulum,* whose larva is very desttuctive to deal palings, on which it feeds. The genus *crysomela* affords abundance of very splendid insects for the microscope. I send you *c. vitellinæ,* a small but splendid species; together with various others, which you will find very beautiful.

I also send you a few beetles which I found in a small pool of water on Epping Forest, *hydrochus elongatus,* and *helophorus dorsalis ;* the characters and colour on the head and wing-cases of these, are very fine when viewed under the speculum.

I likewise send you a small insect, the *necrobia ruficollis,* highly interesting to entomologists, on account of a similar species, which was, in a great measure, connected with the means of preserving the life of a worthy and most useful man. Latrielle, the celebrated entomologist, was, during the French revolution, arrested and thrown into prison, and, like many others, he was condemned to death. Midnight was the time appointed for his execution. The officer arrived at his dungeon unperceived by Latrielle, and found him busily engaged in examining a species of this insect, and uttering pious ejaculations to the Almighty; throwing himself under the protection of that Being who, manifesting

so much wisdom in forming and providing for the wants of so minute an insect, would not overlook the situation in which he was at that time placed! The officer had studied entomology, and had experienced much gratification in that delightful part of natural history. He had also heard a very favourable account of Latreille, and now became warmly interested in his behalf. He entered into conversation with him, and determined on saving his life if possible. He was enabled to do so, in consequence of a person having died in the prison whose figure resembled his. He liberated and secreted him until the storm was blown over; substituting the dead body in the room of Latrielle's!

I also send you an object, the poison from which occasioned the death of a collector of insects. Mr. Sharpe, who, while collecting insects in Combe Wood, met with a viper; he had often been in the habit of catching and selling them, and therefore made no hesitation in laying hold of this. But, in consequence of his taking up some dried leaves with the viper, his grasp was not sufficiently tight, and the animal bit him twice. Sharpe, not thinking it of any consequence at the time, continued collecting, until he became so ill as to be incapable of joining his companions; who, some time afterwards, found him on the ground, in great agonies, and very much swollen. The poison had done its work! He was conveyed home, and in a few days died. The object is the fang from the jaw of this identical viper, and in which you will perceive the aperture through which the poison was ejected.

There are some curious remarks made by the Rev. W. Derham, on the poison of vipers, in the second volume of his Physico-Theology, page 339.

You will find the wood louse, *oniscus sellus*, a very interesting object to examine its various parts, and particularly its brilliant and numerous eyes, which appear like clusters of diamonds, neatly set. I have sent you two specimens, placed in different positions, in order to exhibit the various characters. Swammerdam relates a ludicrous mis-

take of a servant maid, who, finding in the garden a great many of these insects in a globular form, imagined she had discovered some handsome materials for a necklace, and betook herself to stringing them with great care; but, on suddenly perceiving them unfold themselves, she was seized with a panic, and ran shrieking into the house! Though considered but of slight importance in the present practice of physic, yet these animals once maintained a very respectable station in the *materia medica*, under the title of millepedes; they being regarded as being aperient, resolvent, &c. They were ordered in cases of jaundice, asthma, and many other disorders; and were either taken living, being swallowed like pills, in their contracted state, or variously enveloped in syrups and marmalades; but were more generally reduced to a powder, and thus mixed with other ingredients.

I likewise send you a piece of card, on which I have placed some minute muscles, that I met with in a pond, swimming about with great velocity. These are not larger than the head of the smallest pin! I have placed them in different positions, in order to procure a view of the various parts of the shell; some of the shells I have set open, within which the fish may be seen; on one of these I observed the exterior of the shell to be covered over with the habitations of minute aquatic animals; the form of these habitations are very singular, regular, and curiously marked. Although this muscle appears to our eyes so minute, yet how large it must have appeared to those animals that had constructed such numerous habitations on its surface!

I have before observed, that the various species of *cimices* offer an almost unbounded field for the collection of splendid objects for the microscope. I now send you a few, among which you will find one very rich in colour; another minute one, beautifully marked on the antennæ, head, and thorax; this is a very scarce insect, and, according to the modern system, constitutes a new genus, *berytus clavipes*. Also some which I found running very nimbly on the sur-

face of the water, *cimex paludum.* These are covered with fine down, resembling a coat of velvet. The back appears hollowed out, giving that part the appearance of a boat. These insects, I find on dissection, are furnished with a proboscis, within the sheath of which are contained several instruments, adapted for the purpose of extracting the juices from plants, &c.

I also send you a curious species of *ptinus, p. sulcatus,* the antennæ of which are beautiful, and covered with minute scales, as are also the legs; the larvæ of this insect make sad depredations in libraries, by perforating those round holes which are so frequently observed passing through all the leaves of a book! I have before observed, that several volumes, which had lain some time on a shelf undisturbed, had been so regularly perforated by a single larva of this species of insect, that a string might have been passed through the hole in each, and all the books suspended by it! The genus *attellabus* you will find a fair object for the microscope, in the markings of the proboscis and wing-cases; as such I send you a specimen.

I also send you a very singular fly, *bombylius major,* or sword bee-fly; so termed in consequence of its having a very long straight proboscis, within which are enclosed four instruments, for opening, piercing, and sucking the nectarious juices of flowers; and when in the act of doing this, they do not settle, but keep constantly buzzing upon the wing. I have dissected the proboscis, and have placed the trunk, with the four instruments displayed, between slips of glass; as also its numerous eyes, which are of various shapes and sizes. These dissections you will find exceedingly fine objects for the microscope.

I likewise send you a species of the leaf-cutting bee, *apis centuncularis,* with a dissection of its head, sting, &c. And as the habits of these insects, in the construction of their nests, are somewhat singular, so I furnish you with a brief statement of them. These insects form cylindrical nests, of the leaves of the rose and other trees, which are

sometimes of the length of six inches, and generally consist of six or seven cells, each shaped like a thimble. They are formed with the convex end of one fitting into the open end of another. The portions of leaf, of which they are made, are not glued together; nor are they any otherwise fastened than in the nicety of their adjustment to each other; and yet they do not permit the liquid honey to drain through them. The interior surface of each cell consists of three pieces of leaf, of equal size, narrow at one end, but gradually widening at the other, where the width equals half the length. One side of each of these pieces is the serrated margin of the leaf from which it was cut. In forming the cell, the pieces of leaf are made to lap one over the other, the serrated side being always outermost, till a tube is thus formed, coated with three, four, or more layers. In coating these tubes, the provident little insect is careful to lay the middle of each piece of leaf over the margins of the others, so as by this means both to cover and strengthen the junctions. At the closed or narrow end of the cell, the leaves are bent down, so as to form a convex termination. When a cell is formed, the next care of the bee is to fill it with honey and pollen, which being collected chiefly from thistles, form a rose-coloured paste. With this it is filled to within about half a line of the orifice; and she then deposits in it an egg, and closes it with three perfectly circular pieces of leaf, which coincide so exactly with the walls of the cylindrical cell, as to be retained in their situation without any gluten. After this covering is fitted in, there still remains a hollow, which receives the convex end of the succeeding cell. In this manner the patient and indefatigable insect proceeds, until her whole cylinder of six or seven cells is completed. This is said to be generally formed under the surface of the ground, or in cavities of walls, and in decayed wood, in a fistular passage, which it entirely fills, except at the entrance. If by any accident the labour of these insects is interrupted, or the edifice is deranged, they exhibit asto-

nishing perseverance in setting it again to rights. Their mode of cutting out pieces from the leaves for their work, deserves particular nótice. When one of these bees selects a rose-bush with this view, she flies round, or hovers over it, for some seconds, as if examining for the leaves best suited to her purpose. When she has chosen one, she alights upon it, sometimes on the upper, and sometimes on the under, surface; or, not unfrequently, on its edge, so that the margin passes between her legs. Her first attack, which is generally made the moment she alights, is usually near the footstalk, with her head turned towards the point. As soon as she begins to cut, she is entirely intent on her labour, nor does she cease till her work is completed; this is done, with her strong jaws, with as much expedition as we could exert with a pair of scissars. As she proceeds, she keeps the margin of the detached part between her legs, in such a manner, that the section keeps giving way to her, and does not interrupt her progress. She makes her incision in a curve line, approaching the midrib of the leaf at first; but when she has reached a certain point, she recedes from this towards the margin, still cutting in a curve. When she has nearly detached the portion she has been employed upon from the leaf, she balances her little wings for flight, lest its weight should carry her to the ground; and the very moment it parts, she flies off with it in triumph, held in a bent position between her legs, and perpendicular to her body.

The larvæ of the leaf-cutting bees do not differ in appearance from those of the hive-bees. When arrived at their full size, they spin a coccoon of silk, thick and solid, which they attach to the sides of their cell. Those produced first, are from the first laid eggs; so that when ready to emerge into the air, in passing through the bottom of their cells they do not interrupt each other's progress. These larvæ are exposed to the attacks of other insects, that make their way into the cells and deposit their eggs there. This mode of forming a nest is not confined to the present species, as

several others pursue similar operations, adopting the leaves of other trees than the rose for this purpose, as the horse-chesnut, the elm, &c. One of the cells constructed in the above manner I now send for your inspection.

In June, 1826, in walking through a lane near Englefield Green, I discovered in a bank, the holes or passages leading to the nests of several species of wild bees. Among them I observed many of the larger white and orange-tailed kind. This bank, for thirty or forty yards in length, was perforated in many places, at a distance from each other, with holes sufficiently large for the entrance of those bees, many of which I saw go in and come out. One species of orange-tail I found dead on the bank; it being a very fine specimen, I preserved it, and now send it to you. You will observe the sting protruding from its abdomen; and if you examine the pair of darts under your microscope, you will find them interesting objects.

With this I send you the dissected head of *scarabæus pilularis*, for your examination. I likewise send a female specimen of the genus *sirex*, the tailed wasp; this species is *s. dromedarius*, the larva of which is very destructive to timber, that being its principal food. You will observe, at the end of its abdomen, a serrated sting, and which the insect also uses as a saw, in perforating the trees, in order to deposit its eggs. When the young grubs or larvæ are excluded from them, they commence their depredations on the wood. Although this material is their principal food, yet they also frequently eat their way into the bowels of other insects, their larvæ living upon and consuming their vitals. But the perfect insect lives on the juices from the nectaries of flowers. This insect deserves your close inspection under your microscope, and particularly the jaws, wings, and the saw or sting, with the sheath divided into two parts, &c. One of these saws I have dissected, and placed between slips of glass. You will observe it is composed of three separate pieces, each piece being serrated, and also toothed; the sheath is also between the same slip

of glass, and appears to answer a twofold purpose, viz. of containing the saws when in a state of rest, and also by forming a tube, conveys the eggs from its abdomen into the hole made by the insect with its saws. I have sent you the abdomen of this insect, which you will perceive is filled with eggs; also its wings, which are curiously ribbed. I also send a species of *byrrus*, *b. pilularius*, this is a very singular insect, of a convex shape, and when disturbed it withdraws its head, contracts its limbs, and lies in an inert state, resembling a seed or a pill, whence its name *pilularius*. I have partially opened this insect, in order to show you in what manner it folds up its head, legs, and particularly the last joint of the leg, it lying under the second joint. The characters about the head, thorax, and antennæ are well adapted for viewing under the microscope. As are also the curious flat shaped heads of two species of *hymenopterus* insects, I took near Windsor, in June, *bethylus punctata*, and which I also send you for that purpose.

With the foregoing I likewise send you a species of aquatic hunting spider, which I observed seeking for its prey in a very singular manner; and as I had never before witnessed any circumstance of the kind, I was highly interested in watching the motions of this little hunter, in catching its prey. I was walking on the bank of the New River, when my attention was directed to the surface of the water, on which I saw several gnats undergoing their transformation from the pupa state into that of the perfect insects. While I was viewing this interesting scene, and considering how liable they were to the attacks of their enemies, the fish, my attention was suddenly taken off from them, to a species of hunting-spider, which sprung from the bank to the surface of the water, and, with rapid bounds, proceeded to the nearest gnat, which had just quitted its pupa case, and was resting itself, in order to recover from the fatigue of the exertions it had undergone, in effecting its great change. The spider immediately seized it in its fangs, and was bringing it to shore, when I

secured both the captor and the captive! The gnat I lost, but the spider I have placed on a pin, with its fangs set open, and which you will find in the box containing the other objects.

In your present volume, page 101, you make mention of the devastations committed on various species of property by the white ants and other insects. I herewith send you a Bible, which has been the object of attack by the former insects; together with the following statement of facts concerning it, from a friend. He informed me, that two thousand copies of this Bible had been sent from this country to the Missionaries in India; and that when the vessel was unladen, it was discovered that the white ants had actually destroyed eighteen hundred copies; and the remaining two hundred were in such a state as to be rendered useless! The copy which I now send is the only one out of the two hundred that is legible in every part; yet in this you will observe how far these insects have eaten into the margins of the leaves, and also into the cover.

In thus furnishing your readers and yourself with numerous lists of objects for the employment of your microscopes, I trust that they and you will be enabled in future to follow up the subject, which is certainly inexhaustible. This unrivalled instrument, the microscope, will teach them and you that even a single grain of sand may harbour within it the tribes and the families of a busy population! Witness the numerous cells contained in the grains of sea sand, many of which I have before shown you, composing the habitations of minute polypes. It will teach you, that in the leaves of every forest, in the flowers of every garden, and in the water of every pool, there are worlds teeming with life, and as numberless as the glories of the firmament; to prove which, you have only to observe the numerous aphides on the leaves of trees and plants; the incredible numbers of various species of minute insects, found within pinks and other flowers, in the summer months; and the countless myriads of animalculæ in the green scum cover-

ing ponds, or even in a minute drop of water, in which hay or pepper has been infused! Nature shows her wonders in the minutest as well as in the largest objects. Whether we consider the structure of the mite, or that of the towering elephant, we shall find her alike excellent; she has formed them both with the same degree of propriety of construction. It is our senses which are not sufficiently acute to perceive the organization of very small bodies, which often escape our observation, unless we have recourse to foreign assistance. Were we not assured of it by daily experience, could we imagine that there are animals, which, being a million times smaller than a grain of sand, have yet organs of nutrition, motion, and generation. There are shell-fish so minute, that even when seen through a microscope, they scarcely appear so large as a grain of barley. Nature is as regular and as exact in diminutive objects, as in those immense bodies, the circumference of which we are obliged to calculate by millions of miles. The Creator extends the same beneficent care to the mite that crawls in the dust, as to the whale which floats upon the waves. The more we contemplate the works of God, the more will the proofs of his power be multiplied. We are confounded by the two extremes of Nature, the great and the small; and we scarcely know whether to admire the Creator most in the immense spheres which roll their orbs in the heavens, or in those minute productions which are almost imperceptible to our eyes, assisted by the most powerful microscopes! The invention of this instrument has increased our knowledge of the variety of organized beings in a most amazing degree; it extends the boundaries of the organs of vision, enables us to examine the structure of plants and animals, presents to the eye myriads of beings, of whose existence we had before formed no idea; opens to the curious an inexhaustless source of information and pleasure; and furnishes the philosopher with an unlimited field of investigation. It leads, to use the words of an ingenious writer, to the discovery of a thousand wonders of His hand, who

created ourselves, as well as the objects of our admiration; it improves the faculties, exalts the comprehension, and multiplies the inlets to happiness; it is a new source of praise to Him, to whom all we pay is nothing of what we owe; and while it pleases the imagination with the unbounded treasures it offers to the view, it tends to make our whole life one continued act of admiration! Let us therefore make the contemplation of the works of God our most agreeable employment. The trouble that we take in studying them, will be amply compensated by the pure and innocent pleasures that they will procure us. Every-thing in nature is connected together. No creature is useless, or placed without design; although the use of many animals is unknown to us. Thus, seeing the apparent destruction and disorders in Nature, it ought to make us look up to a God who has created nothing in vain; who preserves nothing without a reason, and who, if he permits any thing to be destroyed, it is not without a wise design. If we are thoroughly convinced of these truths, all the works of God will lead us to glorify and bless Him.

> "Nature with open volume stands
> To spread her Maker's praise abroad;
> And ev'ry labour of His hands
> Shows something worthy of a God."

I remain, dear sir,

Your obliged friend,

THOMAS CARPENTER.

To T. GILL, *Esq.*

Remarks and Additions. By the EDITOR.

In plate IV. fig. 1 is a very singularly shaped scale, taken from a dolphin.

Fig. 2, part of the membranous envelope, contained in the body of a fresh-water muscle, together with the minute shells of several young muscles attached to it, and as they appeared when highly magnified under the power of Mr. T. Carpenter's microscope for opaque objects.

Fig. 3, several of the irregular hexagonal cells, with circular spots in the middle of each, which surround the black antennæ of a bee, *eucera longicornis,* viewed on a highly magnified scale.

Fig. 4, the head, and singularly curious antennæ, of a species of cynips, highly magnified.

Fig. 5, one of the poison fangs of a viper, which caused the death of Mr. Sharpe, the naturalist, as described by Mr. Thomas Carpenter. The aperture near its end, through which the poison was ejected, is very clearly shown in this magnified view of it.

Fig. 6, part of the antenna of the *ptinus sulcatus,* a single tuft of which is shown on a still more enlarged scale, in fig. 7, and in which the hairs and scales which cover it are clearly seen.

Fig. 8, one of the antenna of the *berytus clavipes,* highly magnified.

Fig. 9, the rostrum and four instruments of *bombylius major,* shown on a greatly magnified scale.

Fig. 10, the saw of *sirex dromedarius,* shown as united; and in fig. 11, as divided into three separate parts, upon a highly magnified scale.

The Bible mentioned by Mr. T. Carpenter as being one of the two hundred which escaped entire destruction by the white ants, out of two thousand sent out to India by the Missionary Society, exhibited a curious instance of the mischief occasioned by those insects. The margins of the leaves had been perforated close to the letters, and entirely converted into a white powder, where the insects had attacked them.

(*To be continued.*)

XLIX.—*On diminishing Human Labour in the Cultivation of Cotton, Sugar, &c.* By JOSIAS BOOKER, *Esq.**

THE large gold medal, being the premium offered for the most successful attempt to apply machinery worked by cattle, in aid of the labour of Slaves, in our American colonies, has been awarded to the above gentleman. The object of the Society, in offering this premium, was to induce the planters to make trial of agricultural and other simple machines, adapted to their circumstances; and thus to convince themselves experimentally, that, of all the modes of performing common agricultural operations, and bringing the rough produce into a marketable state, the labour of slaves is by far the most expensive and unprofitable: a farther object was to mitigate the situation of the slave, by transferring the severest labour to cattle and machinery.

Mr. Booker's communication, in claim of the premium, is a simple and very interesting detail of the gradual adoption by him of cattle labour, and simple machinery, in aid of Negroes, in cultivating a cotton plantation at Demerara, and preparing the produce for exportation. On many kinds of work, the saving of expense amounted to no less than fifty per cent.; and as this took place chiefly in the most laborious departments, namely, by the substitution of the plough for the hoe; and in working by cattle, the machine for ginning the cotton; the situation of the Negroes was proportionally amended, not only by diminishing the sum total of labour to be performed, but by making that diminution to fall chiefly upon the oppressive forms of it. What is better still, Mr. Booker's wise humanity was not confined within the bounds of the estate committed to his management, but his neighbours had the discernment to see the advantage that he was deriving from it, and the

* From Vol. XLVII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, Adelphi.

good sense, in several instances, to follow his example. May the good seed that has thus been sown, grow and prosper; and may the Society have the satisfaction of bestowing more medals for this object, and of recording the names of those, whose enlightened good sense has demonstrated, that the interest of the master is inseparably connected with the content and ease of his bondsmen!

Poplar Grove, near Liverpool,
SIR, *November 20, 1828.*

I HAVE the honour of transmitting to you a detailed account of the methods adopted on Plantation, Broom Hall, for the purpose of diminishing human labour in the cultivation of cotton, by the substitution of agricultural machinery, and the use of cattle.

My brother, Septimus Booker, who is the bearer of this, will leave with you a plan of the estates, which will show the relative position of the places better than I can explain them. The cultivation on Broom Hall, Fairfield, Land of Promise, and Palmyra, is conducted by the people on Broom Hall; I have therefore included the whole under that name in the detail.

Should I have failed in making myself fully understood, I shall have great pleasure in giving any further explanations you may wish for.

I am, Sir, &c. &c.

A. AIKIN, *Esq. Sec. &c. &c.* JOSIAS BOOKER.

This part of the colony of Demerara was originally laid out in lots of 400 yards broad, commencing at the sea-beach, and running in a straight line nearly from north to south. Some of the plantations consist of one lot, and others of two lots and upwards.

The depths usually granted for cultivation being 1500 rods, or 6,000 yards; the land best adapted for cotton is most commonly within the first depth of 3,000 yards. The whole coast of Dutch Guiana, of which Demerara is but a portion, is a regular flat; and the first operation of the

planter, on getting possession of a new lot, is to enclose it by a trench, of from eight to twelve feet wide, and four feet deep; the earth thrown up forms a regular bank round the plantation, for the purpose of excluding the Savannah water on the one hand, and the overflowing of the spring-tides on the other.

Up the middle of each lot, and about thirty feet apart, are two trenches, of similar dimensions to the one before named, the earth from both being thrown up together, forms what is usually called the middle dam, which is used as the principal road to visit the different parts of the estate.

The before-mentioned trenches divide each lot into two equal parts of 200 yards broad, so that each part, or division, is enclosed by a trench of from eight to twelve feet wide, or wider sometimes, when the depth of the plantation is greater; of course, the more land you have to drain, the wider the trenches will be required to be, to let off as much water as possible, during the ebb tide.

On each division of 200 yards, between the trenches, are transverse open drains, of about two feet wide, and one and a half feet deep; these drains are apart from each other, from twenty to forty feet, according to the nature of the soil.

As efficient drainage is an object of the first consideration, the judicious planter takes care to have his sluices of sufficient dimensions, to drain the land in time, to prevent injury to the cultivation.

The nature of the land in this district, to which I shall confine my observations, is stiff, adhesive clay; and, from frequent hand-hoeings for a period of thirty years, it has become incrusted, and impervious to the rains,—the water lodging, where the beds, or spaces between the transverse drains, are not sloped off from the middle.

The cotton trees are in size and shape nearly similar to a luxuriant currant-bush, and thrive best on porous land, kept free from weeds, &c., and with a trimming or pruning

once a year. The trees are raised from the seed, and are in full bearing from the second to the fourth year; they continue bearing to the seventh year and upwards, upon a favourable soil. I have always found it most profitable to renew the cultivation every fifth year. It has been observed on cotton land generally, that the trees lose their size and vigour, when the land has been some time in cultivation, and more particularly in a clayey, adhesive soil.

I have heard some of the old planters remark, that when this coast was first planted, the trees were so vigorous, as to cover the ground at a distance from each other of ten feet. Weeding once a year was then quite sufficient, and in some cases, once in two years; the crops hardly ever failed of being most abundant; but now, the common practice is to plant at three and four feet apart, in consequence of which the trees are stunted, and frequent hand-hoeings, or weedings, are necessary, to prevent the couch-grass from smothering the trees. Now, I apprehend this falling off does not proceed so much from the exhaustion of the land (nothing being taken from it but the cotton), as from an increased compactness, occasioned by repeated hoeings and tramplings; and the consequent difficulty which the roots have in penetrating the neighbouring earth in search of proper nutriment. Another disadvantage has arisen from the want of porousness in the land, namely, that the water lodges on the beds, if great attention is not paid to their shape. If they happen to be too much rounded off, the best part of the soil is washed into the small drains, and carried away through the sluices, of course to the injury of the land. It is no unusual occurrence, to lose one-fourth of your stand of trees, in a heavy wet season, from bad drainage; together with small pools of standing water, on the inequalities of the beds. In this state of things, it seemed to me absolutely necessary, that something should be done towards destroying the sour-grass, and giving to the land a perfect surface drain-

age; and, at the same time, to loosen the texture of the soil; ploughing, of course, appeared to be the only remedy; but that had frequently been attempted, and as often failed; and the idea had been given up, as a thing impracticable in a tropical climate. Again, it could not be performed with horses, because of the open drains, into which they were liable to slip, and get fast.

Never having seen oxen worked, I laboured under a disadvantage; however, seeing with what great facility Mr. Tongue formed a team of oxen, on a neighbouring estate, in 1820, I commenced the use of cattle. Our first work was hauling timber, and dragging punts, or boats, to the buildings. We found great advantage in a draught-horse being put before them, until they got accustomed to the yoke. The cattle were yoked as in Devonshire, myself and assistant constantly superintending them, until a young Creole, named Douglas, was competent to take the entire management of the cattle and plough. I am indebted to Mr. Lucas for the gift of the first plough we used; it was made near Lancaster, of the description commonly used in that neighbourhood: the ploughman was considerably eased by the use of the wheel.

The field selected for our first operation, was one of about eight acres, in a low part of the estate, of an inferior soil, and notorious for a bad stand of cotton. Not having sufficient time to give it a regular deep ploughing, before the season for planting was too far advanced, we commenced with making only one-bout ridges, or banks, parallel with the transverse drains, eight feet apart, the intervals remaining as before: both head-lands were similarly ridged across the beds, the furrows answering as small drains, through which the water was conveyed into the head-land furrows, and thence into the open drains. In a few days the land thus thrown up pulverizes, then the cotton-seed is planted on the tops of the ridges, six feet apart. The labour bestowed upon this field, and others similarly treated, will be shown in the comparative state-

ment of labour, at the end of these notes. To the practical planter, it is an object of the first consideration, to get his cotton-trees to cover the ground, and keep down the weeds,—a considerable saving is thereby effected in the labour of weeding. The trees in this field, at five or six feet distance, covered the ground better than those which, according to the usual mode, are set at three or four feet distance. One of the advantages attending this method is, that the young trees, being on the bank, and a little elevated, and also partially cleared, thus get the start of the grass and weeds, and are raised with less labour than is commonly bestowed upon young cotton in the old system; and, especially, as no trees are lost, from the water standing in the hollow parts of the beds. The quantity of cotton picked from this field, was equal to that gathered from the best land on the property; although the year was not what is usually called by the planters "a good cotton year."

In the year 1822, I had given to me the materials of an old mill, imported by the late Mr. Rutherford; these we formed into a cattle-mill, for turning ten of the gins in common use. Invalids, and children of from ten to fifteen years of age, after a little practice, would bring 75lbs. of clean ginned cotton per day; which is one-third more than the general average of work done in that part of the country by the strongest men in the gangs, with hard labour! I have a letter, dated 24th of September last, wherein my brother, who is my successor, states, that they received from one gin 500lbs. of cotton per day. This gin I had made by Messrs. Fawcett and Co., of Liverpool, who have afforded me a drawing of it to accompany this.

In the year 1823, as we began to feel the advantages of our cattle and machinery, more breadth of land became necessary to employ our means to advantage; accordingly, the abandoned plantation, Fairfield, was added to Broom Hall. This estate comprised a lot and a half, with a frontage of 600 yards; the cultivation had been neglected

for a length of time, and the whole estate allowed to run into high grass, or black sedge. By this time our people felt, and loudly expressed, the ease they derived from the use of the plough.

We continued extending our cultivation on Fairfield, chiefly on the principle of the one-bout ridges, until our cotton-fields were as extensive as when the property had 250 people upon it, without having given up more than 50 acres of the old cotton ground on Broom Hall.

As the advantages of the system were demonstrated, applications were made by persons, both in Berbice, and Demerara, to be allowed to send Negroes and cattle, for instruction and training, in ginning and ploughing. The estate was benefitted by their gratuitous services, for six, eight, and sometimes twelve months together; and, as an encouragement to Douglas, and his assistants, the owners of the parties so instructed, paid twenty-two guilders * for each ploughman, and one guilder a-piece for the oxen fit for general work.

No plantains can be raised where this estate is situated, for want of suitable soil; and the supply of that article, as provision for the Broom Hall negroes, was derived from one of the new locations for provision ground, above all the former settlements, in Mahaica Creek, obtained in the year 1819. The front of this lot was four miles from the buildings on Broom Hall. The plantains had been brought from it overland, on the Negroes' heads, once a fortnight; and, when the tide suited, in a punt, drawn by men, through a navigable canal. In the first instance it occupied the whole gang half a day; and in the alternate week, three men for three successive days. The whole of this work was afterwards performed on Saturdays by a team of oxen and two boys! I well recollect the satisfaction manifested among the people, when the punt brought one of the first loads of plantains, by the aid of cattle, through the

* A guilder is one shilling and eight-pence, when the exchange is at twelve to the pound, being the par.

canal; it happened at a time when the tides were low, and consequently there was very little water in the canal; and even in some places actually nothing but soft mud. The punt had a load of 300 bunches of plantains, weighing from seven to nine tons. After the punt was once put in motion, it appeared to move with the same ease as when afloat. I asked a Negro, named Cudjoe, who was present on that occasion, what he thought of it? and if he had ever seen any thing like it before? His answer was (translating Negro jargon into English), "No, master, never; the longer I live, the more I see: these oxen are *our Negroes now*—they do the hardest work at this time, and if master were to give them a regular allowance of provision every day, they deserve it certainly; and had all the men on the plantation been put to drag the punt, they would not have moved it."

The saving of manual labour by the use of the cattle, in various ways, is immense. We not only brought the plantain, but timber, posts, spars, gin-roller wood, &c. from the Creek, and all other materials necessary for building, and repairing buildings. The cattle were also employed in carting shells to the public road, which had heretofore been brought by the Negroes on their heads.

In the course of time, when our fields of cotton were extended and well covered with what was considered a good stand of trees, we devoted a little more attention to a couple of fields, measuring about twenty acres, by putting them under a regular course of tillage. One clean ploughing and harrowing in the dry season was sufficient to pulverize the ground and destroy the weeds. While I remained in the country, which was above twelve months afterwards, neither of those fields had been weeded, except just about the roots of the cotton-trees. We made use of a moulding-plough, with a very broad-winged sock, to loosen the earth and destroy the weeds in the intervals. A short time before I resigned the charge of the estate, we used for

the same purpose a cultivator, set with coulters, and duck-footed lines.

One of the fields above alluded to, was nearly in the middle of Fairfield, on what we called "Congo ground." The land was completely covered by the trees at seven feet apart; it yielded well, and was less affected than the other fields with drought. The other ten-acre field had been salted, by the tides running in and out, for upwards of four months, for the purpose of destroying what is usually called "the devil's-grass;" it was afterwards ploughed, harrowed, and planted with cotton-trees at four feet apart; the trees barely covered the ground at that distance, yet were very productive. The smallness of the trees I attributed to the land being so very salt.

From my own observations, I have no hesitation in saying, that the horse-hoeing husbandry can be employed with great advantage in cleaning cotton crops; and had I remained in the colony, I should have put the two estates in succession under tillage; and, I may say, I regretted leaving the colony before I had set this branch of improvement fairly on foot. However, what has been done by our feeble attempts at lessening manual labour, is proved by the memorial and accompanying documents to Sir B. D'Urban, the Governor of Demerara. It is also pleasant to reflect, that it was not done by overworking the slaves; as there was only one estate on which the increase of population was so great as that of Broom Hall, at the last registration. The estate, whose births over deaths equalled Broom Hall, has however a gang of about 330 negroes, which is 148 more than that of Broom Hall.

The people on this latter property are comfortably supplied with food and clothing by their respectable owners*; and when the apportioned work of the day is over, it frequently occurs that the industrious have spare time to cultivate their plots of ground, the produce of which, if

* John Bond, Esq. Lancaster, and Abraham Rawlinson, Esq. Fakenham, Norfolk.

not given to their stock of poultry and pigs, is disposed of for some article of luxury, either in food or clothing. As an encouragement, we prepared the land for them, by ploughing and harrowing.

I witnessed with pleasure the manners and habits of the Negroes to improve with their property. I had more reason to complain of their want of thought and consideration than any deficiency of talent.

Before I left the colony, in May, 1827, my example had been followed by several other planters, both in Berbice and Demerara. There were then eight ginning-mills at work; and several estates, both cotton and sugar, had entered into a system of tillage with great prospect of success. Five or six of the wood-cutters had introduced oxen into their establishments for hauling timber, thereby effecting an immense saving of manual labour; besides this, there are many others employed in drawing carts and punts for transporting the produce of the estates to the places for shipping it, and in bringing home the supplies.

The labour of the cattle, instead of being a cost to the estates, has been a source of revenue: the cattle being worked while they are young, pay by their growth the interest of their purchase-money and grazing. They are not worth more than six joes* a-head when first brought to labour; and after two years' work, are readily sold at eight and nine joes each.

The cost of the ploughs, harrows, harness, &c. was more than covered by the earnings of our ginning-mill, after our crop was ginned off.

* A joe is twenty-two guilders.

A Statement of Labour required for Ten Acres of Cotton, for two successive Years.

OLD SYSTEM.

	Days.
Weeding and levelling the beds, preparatory to planting	60
Running the lines and placing the line-sticks . . .	4
Planting the seed, three and a half feet apart . . .	23
Moulding, singling the plants, and supplying the vacant places with seed, 180 rows, six to each person for a day	30
Five weedings in two years, six persons to an acre .	300
One pruning the second year	20
	437

NEW SYSTEM.

Running the lines and placing the line-sticks . . .	4
Ploughing 103 banks, with six oxen, one man, and three boys, two and a half effective men, six days .	15
Ploughing head-lands	3
Planting 103 banks . . . . :	13
Weeding, moulding, and singling the plants . . .	17
Three times weeding during two years, five persons to an acre each time	150
One pruning the second year	20
Balance in favour of this method	215
	437

The difference in labour in favour of the new system is 215 days, which is annually a saving of ten and three quarter days for each acre in cultivation.

A Statement of the Labour expended on a Ten-Acre Field under tillage, for one year only; the second year it is supposed would be less.

	Days.
One clean ploughing, with one man and three boys, which occupied them fifteen days, the man and boys reckoned at two and a half effective days . . .	42
Harrowing ditto	7
Running the lines and planting seven feet apart . .	17
Weeding, singling, and moulding the rows twice . .	34
Once running the plough, with a broad-winged sock, through the intervals between the cotton	10
	110

Ginning Cotton.

To gin a bale of cotton, 300lbs. Dutch weight, with foot gins in this district, did not take less on an average than seven days, allowing for rests, the work being very hard	7
Cleaning, six persons to a bale	6
	13
According to the method now adopted, it requires one man and four boys to gin a bale and a half; there being little or no broken seed in it, three persons are sufficient to clean it, which will be for a bale and a half ginning and cleaning	6½

Being a saving of eight and two-thirds of a day's labour upon each bale of cotton, and very easy work to the people employed. Four well-grown cattle are sufficient to work two gin-heads, which would gin from 900 to 1000lbs. per day.

JOSIAS BOOKER.

George Town, Demerara,
May 5, 1827.

DEAR SIR,

HAVING been proprietor of the cotton estate, Prospect, in the neighbourhood of Broom Hall, for upwards of twenty years, I may be presumed to possess some experience in that branch of cultivation.

I well know the soil in the vicinity of what is called Little Courabund, is, perhaps naturally, as unfertile as any on the coast of these colonies, and that it had for several years back been exhausted by long cultivation.

I have therefore witnessed with much gratification the great increase in your crops, which may be attributed to your system of management.

I am persuaded that its general adoption would produce the most beneficial effects, especially by the great saving of labour to the working classes.

Wishing you success, and a prosperous voyage,

I am, Sir, &c. &c.

J. D. GODDARD.

JOSIAS BOOKER, *Esq. Broom Hall.*

L.—*On English Bone Glue**.

Mr. WALTER MACQUEEN, of 8, Marine-street, Brighton, communicated to the Society of Arts a sample of bone glue, prepared by him in the following manner:

The bone, previously deprived of its fat, is to be macerated in muriatic acid, diluted with twice its bulk of cold water. When the phosphate and carbonate of lime have been thus removed, a mass of glutinous fibre remains, which is to be repeatedly washed in warm water, till the whole of the acid is got rid of. It is then to be put into a covered digester, furnished with a valve, with a proper quantity of water, and is to be kept at a heat not exceeding two hundred degrees of Fahrenheit, without stirring, till the solu-

* From vol. XLVII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, Adelphi.

tion is completed. The thick liquor is then to be poured into a box, and allowed to become cold, when it will be found to have acquired the consistence of a stiff jelly, and is to be cut into cakes, and dried in the usual manner. Five pounds of bone, and five pounds of muriatic acid, yield one pound of glue, of an orange-yellow colour, dry, hard, brittle, and of less specific gravity than glue from skin.

Part of the specimen sent by Mr. Macqueen, was put into the hands of the carpenter usually employed by the Society; and who reported, that he took equal weights of bone-glue, and the best London-made glue, and soaked them for a night in water; they were then put into separate pots, were just covered with water, and were boiled. The bone-glue was quite thin, and did not require more water; the other glue boiled thick, and it was necessary to add more water, in order to bring it into a state fit for use. The solution of bone-glue was found to *chill, i. e.* to become gelatinous much sooner than the other; and is, therefore, not applicable to cementing long joints, but it answers very well for small work. It is also well adopted for laying veneers, being stronger than common glue, making a closer joint, and not being liable to be affected by damp.

The Committee of Chemistry directed the secretary, Arthur Aikin, Esq., to make some comparative experiments, which was accordingly done, with the following result:

Two varieties of London glue were taken.

No. 1. Common glue, of a yellowish-brown colour, somewhat flexible, and with an odour like that of stale liquid glue.

No. 2. Best London glue, of a darker colour than the preceding, hard, brittle, inodorous.

No. 3. Mr. Macqueen's bone-glue.

Two hundred grains of each were put into separate equal coffee-cups, with two liquid ounces of river water.

On the second day:

No. 1. Has swelled the least, and has a putrid odour.

No. 2. Has swelled the most, and is inodorous.

No. 3. Has swelled nearly as much as No. 2, and is also inodorous.

On the third day:

No. 1. Is less swelled than the others, much of the water remaining unabsorbed, and its odour is very putrid.

No. 2. Has absorbed nearly the whole of the water, and is inodorous.

No. 3. Is in the same state as No. 2.

Each cup was put over the fire, in a vessel of cold water; and by the time that the water began to boil, each of the glues was perfectly dissolved. No. 2 made the thickest solution. No. 1 was thinner. No. 3 was almost as thin as water.

The water lost by evaporation, since the beginning of the experiment, was, in No. 1, 125 grs.; in No. 2, 124 grs.; in No. 3, 78 grs. The real proportions, therefore, of glue and water, in the respective solutions, were,

No.	Glue.	Water.
1	1	8.35
2	1	8.36
3	1	8.82

On cooling, all the three solutions became gelatinous nearly at the same time. No. 1 was an imperfect tremulous jelly. No. 2 was less tremulous. No. 3, considerably stiffer than No. 2.

The glues, thus prepared, were put into the hands of the same carpenter who made the former trials.

At a subsequent meeting of the Committee, three pieces of mahogany were produced (each composed of two pieces), cemented by the three samples of glue. The carpenter reported, that all the solutions were thinner than glue as usually prepared; that No. 3 was by far the thinnest, and, if used quickly, before it had time to chill, a smaller quantity of it than of the others, was required; and that it made a rather firmer joint. He also stated, that, in laying veneers, and in certain kinds of cabinet work, the bones

glue may be used with great advantage; because, from the extraordinary fluidity of its solution, a glue might be prepared, containing twice the proportion of solid gelatine that is contained in other liquid glues, and yet remain quite fluid enough for use. Such a glue would, in many cases, be of great advantage, where extraordinary strength is required.

Of the three specimens of mahogany,

No. 1 broke altogether in the joint; and is, therefore, decidedly the weakest.

Nos. 2 and 3 broke partly in the joint, but chiefly in the wood; and there does not appear to be much difference between them.

LI.—*On the so termed French Glass-Paper. By the* EDITOR.

WE have received from France, of late years, thin transparent sheets of this substance, and which have been found by artists to be greatly preferable to any tracing-paper hitherto employed by them. It is evidently a preparation of gelatine, most probably, bone-glue, and seems to have been formed by pouring a solution of it upon plates of polished glass, and leaving it to become dry. We are not aware that it has hitherto been prepared in this country.

Mr. W. Kelsall, the ingenious engraver, whose method of taking casts of medals in plaster of Paris we have given in page 108 of our present volume, has, we are informed, employed this glass-paper, in making tracings, in the following novel manner. He places it upon the original design, which he wishes to copy, and to transfer, in a reversed position, to the surface of the etching-ground, laid upon his copper or steel plates; and, with a fine etching-needle, and light and even strokes, he draws the outlines of his subject upon the surface of the glass-paper. This done, he rubs over it some patent calomel, which enters into and fills up the lines so drawn; the remainder being

carefully removed from the surface of the glass-paper. He then places the surface of the glass-paper thus treated in contact with the etching-ground, and secures it from slipping; and then, by dexterous light blows upon its opposite surface, he transfers the calomel from the slight incisions made in the glass-paper, to the etching-ground upon his plate.

LII.—*On Substitutes for the French Glass-Paper. By the* Editor.

This material, although excellent for the purpose described in the former article, being, however, scarce and expensive, the Editor thinks it will be acceptable to artists, to be informed of other means of procuring similar, and even more important, results.

Many years since, a person submitted to the Society of Arts, a method of drawing perspective representations of objects, and of transmitting them to the surface of paper. His method consisted in coating the surface of a piece of plate-glass with a solution of gum arabic, and letting it become dry. This glass he then mounted perpendicularly, by placing it in a groove made to receive it in a wooden basis, and which also carried a sliding arm, which supported a metal plate, having a small orifice in its centre, to serve as an eye-piece. The outlines of any object were then to be traced upon the gummed surface of the upright glass, with a fine needle, fixed in a proper handle; the eye of the artist being at the same time applied to the orifice in the eye-piece; and thus a perspective outline of the object might be readily drawn in the thin coat of gum. The glass plate being removed from its stand, the lines traced in the gummed surface were then to be filled with copper-plate printing ink, which was wiped off the surface as usual. A moistened paper being then laid upon the inked surface, the outlines might be transferred therefrom to the paper, by burnishing the back of it with any proper and smooth

instrument. The Editor put this method to the proof, and thus obtained the outlines of the object he drew upon the gummed surface of the glass, transferred upon the paper. The success of the experiment was not, however, sufficient to merit the reward of the Society.

Now, he would suggest, that a thin plate of glass, coated either with a solution of gum arabic, or with a mixture of gum arabic and isinglass, or simply with one of isinglass, might be substituted for the French glass-paper with every prospect of success; and the outlines of any object traced upon it, might be filled with calomel, be reversed, and transferred to the surface of etching-ground, in the manner done by Mr. Kelsall, and as described in the preceding article; and when done with, a fresh coat of gum, &c. would render the glass again fit for service.

We also think that a thin plate of lantern-horn might be conveniently employed as a substitute for the French glass-paper, and at a much cheaper rate; although it would not possess the great advantage of being capable of being used repeatedly, which the prepared glass plates do.

LIII.—*On French embossed and other works, in flattened Straw.*

In a late volume of the *Dictionnaire Technologique,* we find an interesting article on this subject. This manufacture, before the French revolutionary war, had been confined to religious establishments, and especially to those of the Carthusians; and it is to an artist of this class, that the editors of this respectable work are indebted for the first publication of the particulars of the several processes employed in it.

On the choice of the Straw, and its preparation.

The straw of all the cereal plants is not equally fit for these kinds of works; we must choose that which is the whitest and the thinnest, and whose tubes are the largest

and longest. The two-rowed barley, *hordeum distichon*, L. possesses all these desirable qualities. It differs from the common or square-eared barley, in its head being flat, long, and having only two rows of grains; its beards and stems are rough to the touch.

At the approach of the season for gathering it, and when the heads are formed, they visit the fields where it is grown, and select the finest straw, of a yellow colour; they then cut it with scissars, near to the ground, deprive it of its leaves, and examine whether or not it be spotted. The mists and the rain in the spring, produce black spots, which it is impossible to remove; and we must therefore give the preference to those parts of the country where the straw has least suffered from this defect. Before collecting it, an agreement is made with the proprietor of the field, for leave to cut it carefully, provided that the heads be given to him, and which must also be cut off with scissars.

The stems are also separated into lengths with the scissars, by cutting them above and below the knots, which are rejected as useless, as are likewise the sheaths, and the small stems at top, which have too little width to be of any use. The most beautiful tubes are those which are the size of an ordinary writing quill, thin, and free from spots.

When the straw has thus been deprived of its useless parts, the tubes are selected according to their lengths, and placed in boxes, divided into compartments.

On Bleaching the Straw.

When the selection has been made, it is necessary to bleach the straw, and especially that which is intended to be dyed of delicate colours; as we cannot be ignorant, that, in any ordinary dyes, we cannot procure fine colours, unless the matters intended to be dyed approach near to a perfect whiteness. And, although the straw is generally yellow, yet it is not difficult to give it a fine white appearance. We employ the liquid chlorate of lime for this purpose, in a similar manner to that used in the ordinary bleaching

processes; but it is blanched much more easily than linen, and even than cotton.

We need only take this trouble for the most delicate colours, such as a light rose colour, flesh colour, a tender lilac, a pale yellow, celestial blue, or azure, &c. For the less delicate colours, the bleaching of the straw by means of sulphur, is sufficient.

On bleaching the Straw with Sulphur.

The vessel most commonly employed for this operation, is a hooped cask, about three feet high, and open at both ends. About the middle of this vessel, a net, strained upon a hoop, is lodged, the hoop resting upon several nails, driven into the sides of the cask for that purpose. The straw, in handfuls, bound round with thread, is laid upon this net, and crossed with other similar bundles, till the vessel is full. It is covered with a lid, similar to that of a snuff-box, the inside of the rim of which has woollen list nailed around it, in order to cause it to perfectly close the top of the vessel. The whole is also enclosed within a woollen envelope. We must also not forget, either to nail or glue paper all over the inside of the vessel, in order to close all the crevices, which might otherwise suffer the sulphureous acid gas to escape through them.

All being thus disposed, we place underneath the vessel, a chafing-dish, full of burning charcoal, over which we have placed a sheet-iron pan, containing a layer of sulphur. The sulphur, on being heated, inflames; and the sulphureous acid gas disengaged, fills the inside of the vessel, and bleaches the straw. Three or four hours are sufficient for this operation. Care must be taken that the sulphur is thinly spread over the bottom of the iron pan, as, should it be laid in too great a quantity, it would unite, and form a flame, which might reach too high in the vessel, and tinge the straw with an unchangeable blackness. This operation should always be performed in the open air.

When we no longer perceive the odour of the sulphureous

acid gas, we uncover the vessel, and remove the bleached straw.

On the preparation of the Straw before dyeing it.

There are certain colours which the straw will not well take, unless it has been previously opened. This operation used to be a tedious one, but we have considerably shortened it by an instrument of our invention.

The straw must not be in a perfectly dry state, when we proceed to open it, as then, on seizing it at one end, it would break, and be unfit for use. We therefore let it lie all night on the flagged pavement of a ground-floor; this communicates a humidity to it, and damps it sufficiently to enable us to open it readily, and to dress and flatten it.

Formerly, we used a taper wooden spindle, to open the straw with; and, taking the tube of straw in the left hand, with the right hand we introduce the smaller end of the spindle into the bore of it, and, by inclining the spindle in a proper manner, we form a cleft, which we extend the whole length of the tube, by quickly pushing the spindle along in, the direction of the cleft. The straw is then spread open upon the spindle, by rubbing it with a bone or ivory polisher, formed in the shape of a folding-knife. The flattening of the straw is then completed by rubbing it forcibly with the polisher on its bright side, whilst it is laid upon a strong and smooth plank of apple tree. This operation, which is to be performed upon each tube of straw, we think is too tedious; and we have, accordingly, substituted the following in place of it.

We employ a pair of cylindrical rollers, mounted in a frame, in a similar manner to those commonly used in the manufaeture of straw-plait to flatten it; and, in front, we affix to the cheeks of the frame, by means of screws, a steel instrument, made in the form of a snipe's bill, which is pointed at the front end, and spreads or widens towards the rollers; the underside of this instrument is made flat, and its upper side is angular, its sides being formed into

sharp edges. This instrument serves both to open the straw, and to guide it beneath it between the rollers. This construction being understood, the following is the manner of using the machine. We take the moistened straw in the left hand, and cause the pointed end of the snipe's bill to enter the tube of it, and thrust it forwards; the straw rends, and we continue to push it forwards, at the same time turning the rollers, by the right hand, applied to the winch or handle of them, until we see that the straw is seized between the rollers. We then loose hold of the straw, and continue to turn the handle, until the straw has passed through the rollers, and falls completely opened and flattened, at the back of the rollers. We can thus prepare as many as ten thousand straws in a day; whereas before we were only able to prepare about a hundred! The straw thus prepared is now ready to be dyed.

On the process of dyeing the Straw.

Blue.—We take an ounce (thirty grammes) of fine Guatimala indigo, in powder, and place it, in a medical phial, upon a sand-bath; we then add to it two ounces (sixty grammes) of the sulphuric acid of commerce. When the effervescence has ceased, we add fifteen grammes of pure potash. It is then left in digestion for twenty-four hours.

This composition serves to dye blues of various shades. To use it, we put into a proper boiler, placed over a fire, the necessary quantity of water to completely cover the straw which we would dye. When the water boils, we then add the prepared sulphate of indigo, by the help of a wooden spoon, fastened at the end of a staff, and by small portions at a time, until we see that the bath has attained the shade we desire. We then remove the boiler from the fire, and throw the straw into it, but which, however, has not previously been opened or flattened. We keep the straw immersed, and when it has received the proper tint, we withdraw it, wash it in cold water, and leave it to dry.

Sky-blue or azure.—Prior to receiving this delicate co-

lour, the straw must be opened or flattened; it must then be arranged in layers, in a square vessel of glazed earthenware, the layers crossing each other. We then take a portion of the remaining part of the blue dye, put it into another vessel, and add warm water to it; also stirring it to complete the mixture, as well as also adding more water, until we have obtained the required shade; when the bath is thus prepared, we pour it upon the straw, disposed as above mentioned, and with pieces of wood placed in the vessel, and bent in the form of a bow against its sides, we force the straw to continue immersed in the dye. When it has received the proper tint, we wash it, and leave it to dry.

Yellow.—This colour is prepared with *curcuma*, in powder, which we boil in water, until it has received the shade we desire; we then throw into it the straw, in its entire state, not opened, and let it boil, until its tint is satisfactory, when we treat it as directed for the blues.

We dye with the residue of this bath the pale yellow shades upon unopened straw.

Green.—The straw dyed of these shades of yellow, when plunged into baths more or less blue, affords greens of different hues.

Red.—We must use for this colour, and all its shades, straw which has been opened and flattened in the manner above described, for receiving the sky-blue or azure dye; and it must also be disposed in a similar manner, in glazed earthen vessels. So likewise the finest straw, perfectly free from spots, must be chosen. The following is the composition of the bath.

We must procure from the dry-salters the dyed woollen threads, in skains, tinted with a red colour, approaching to scarlet; and boil them for several minutes in water, which holds a little alum in solution; the wool gives up nearly all its colour to the water, and when it has attained the required shade, we pour it upon the straw, and suffer it to remain till cold. The dyed straw must then be washed and dried.

In default of scarlet wool, we may dye a red with cochineal, in the manner practised for silk dyeing.

Rose and flesh colours.—These are dyed with the residuums of the red dyes, which are to be heated, and be poured boiling hot upon the straw, disposed in the same manner as for dyeing azure.

Violet.—For this colour we employ the dyed sky-blue straw, and tint it in a rose bath, according to the required shades.

Lilac.—This straw is first dyed azure, and then flesh-colour.

We likewise dye straw of different shades of red, with Brazil wood, and by means of orseille.

Browns.—The various shades of these colours in straw, are first dyed green, then yellow, then red, and, finally, in a bath of Campechy wood (log-wood).

Black.—The straw is first to be treated with galls, then in a bath of pyrolignate of iron, and, lastly, in one of Campechy wood.

On pasting the Straws.

The straw, whether of its natural colour, bleached, or sulphured, is never employed until it has been previously formed into plates or sheets; that is to say, that it must be polished anew, flattened, and pasted, the one straw by the side of the other, upon leaves of thin paper, in order to prevent them from becoming too thick for use.

Each plate or sheet generally consists of from fifteen to twenty straws, according to their width. They commence by selecting them one by one, in order to regulate their tints; as it is proper to mention, that all the straws, although dyed in the same bath, will not equally present the same tint.

After being thus selected, their edges are cut straight. In order to this, they are placed upon a stout plank of apple-tree, well planed, the straw being spread upon it, with its polished side downwards; it is then nearly covered

with a thin blade of iron, the edges of which are perfectly straight, in such a manner, that a thin thread of straw may project beyond the edge of the rule or blade; this thin thread is then to be cut off, by means of a very sharp knife, passed along it, close to the edge of the rule; the knife resembling in form an erasing knife, or a lancet.

After having thus regulated each straw, on both its sides, and having prepared a sufficient number of all colours, they are to be cemented upon paper, by means of flour paste. We must have at hand a good screw-press, formed wholly of iron, of an improved construction, and of which we shall presently give a description. Upon the flat table of the press, on which the screw is destined to act, we place several small and thin planks of walnut, and between every two planks, three or four leaves of paper. It is between these planks, and in the midst of the paper, that we place the leaves of pasted straw.

This press is, as before said, constructed entirely of iron. Its top and sides are formed of a flat bar of iron, with spreading shoulders, and tenons below, the tenons passing through holes made to receive them, in the bed or table of the press; and holes are made through the lower ends of the tenons, to receive wedges, by means of which, the sides and top of the press-frame are securely bound to the table of it. The sides and top are formed, as before mentioned, of a single bar of iron; the top being flat, and having a circular hole in its centre, to receive the upper end of the stem of the screw of the press, and to steady and guide it; this smaller part, or elongation of the screw, being made cylindrical for that purpose. The sides of the press-frame are formed by the iron bar being bent at a right angle on each side, and prolonged until they reach the table of the press, and are secured by the wedges underneath it, as before mentioned. A cross-bar is passed through holes, formed in the sides of the press to receive the ends of it, at about one-third part of the height of the press, and is firmly secured by screws and nuts. The female screw of

the press is formed in the centre of this cross-bor, which is thickened or strengthened there for that purpose; and two diagonal stays or braces pass from the sides of it, and are inserted in the upper corners of the frame, thus affording a great resistance to the upward movement of the female screw. The screw has a fine sharp thread; and below it, cross holes are made through the solid part, to receive an iron pin or lever, by which the screw is turned either way, as required. Below these holes, the lower end of the screw is connected with the moveable iron plank of the press, by means of a garter-piece, in the usual manner, so as to hang from the end of the screw, and yet allow the screw to turn round within the central aperture formed in its upper surface for that purpose. The ends of the moveable plank have gaps formed in them, which receive the sides of the press-frame within them, and thus the plank is steadied in its movements upwards and downwards.

A dozen thin walnut planks are placed upon the table of this press, and between every two of them a small paper book is laid, which is composed of two sheets of paper, or of eight quarto pages, and thus there are uniformly diffused among them nine books of paper. Finally, these thin walnut planks are surmounted by another of oak, of an inch in thickness, the same size as the smaller or thinner planks.

By the help of these instruments, we now proceed to paste the straw, prepared as above directed.

We first spread upon a smooth table a leaf of very thin paper, the size of the intended plate of straw. We then cover this paper all over with flour paste, by the aid of a proper brush, and we then paste upon it one straw after another, side by side, beginning at one edge of the paper, and thus proceed, taking care that the straws neither overlap each other, nor leave any gap between them; we then wipe them over with a proper cloth, in order to be assured that we have thus removed all the superfluous paste, and with a sharp scissors we cut off, not only those ends

of straw which exceed the paper in length, but also a small slip of the paper itself. We then place this pasted plate under the first plank in the press, between the leaves of paper, and, by means of the iron pin or lever, placed in one of the holes made through the lower end of the screw, we give it a slight degree of pressure, taking care not to compress it too forcibly.

We then take another leaf of paper, and paste straw all over its surface, in the above manner, and place it beneath the second plank in the press, between the leaves of paper. We then withdraw the first pasted plate of straw from the press, and remove it from between the leaves of paper, and which can be readily done, because the paste has not become quite dry; we then leave the damp papers to become dry, and replace the sheet of pasted straw between dry papers. We next lay it between the two lowermost planks in the press, and give it a considerable degree of pressure.

We continue proceeding in the same manner until we have finished as many leaves of straw as the press will contain. We also change the papers at least once, and when all are finished, give them a powerful pressure, and do not touch them until the next day. We then unscrew the press, and remove all the plates of straw, which are then placed between the leaves of a large book.

Having thus procured a complete collection of plates of straw of all colours, in order that we may not be stopped in the completion of any works we may desire to make, we shall proceed to describe the methods of working it.

Manner of working the Straw.

The works in straw with which we are now occupied, are those *in relief*, or more properly speaking, *in bas relief.* The manner of giving this relief to the designs is, by embossing them in moulds, by means of the press. But before describing these extraordinary works, it is of importance to make known the instruments which are indispensable thereto.

On the Manner of making the Moulds.

In order to execute all kinds of works, it is necessary to have a great number of moulds. An example of a medallion will be sufficient to understand the mode of operating. Supposing that we would take the portrait of Charles the Tenth, we employ a five-franc piece. We likewise chuse the newest piece which we can procure; we then take a plate of horn, well extended, flat, and polished on one side (the cutlers and comb-makers prepare these plates of horn). We then cut it square, a little larger than the coin; we next heat strongly, but not red-hot, two plates of forged iron, each an inch thick, and larger than the horn plate, and place one of them under the press; these iron plates should not be heated so hot, however, as to burn the horn. Upon this hot plate we lay two or three pieces of thick pasteboard, moistened a little, and upon these we place the coin with its reversed side downwards, or that which bears the Arms of France, from which we do not intend to take a mould; and upon the face of the coin, which is oiled a little, we place the polished side of the horn plate in such a manner, that the sides of the square should be upright, or correspond with the position of the portrait on the coin; upon these we then lay the other iron plate, heated in the manner above described, so as not to derange their position; we then lower the screw of the press, and squeeze them by degrees. The horn, on becoming heated, softens; we continue to press gently until we perceive that the thickness of the horn is diminished sufficiently to cause us to judge that all the parts in relief of the coin are well impressed into the horn; we then cease to press, and leave the whole to become cold, but do not unscrew the press until twenty-four or thirty-six hours afterwards.

When all is become perfectly cold, we release the press, and shall find a hollow mould of horn exceedingly sharp and well defined, without the coin being injured in the

slightest degree*. We next pierce a hole at each angle of the horn plate, and fix short brass wire pins in each, riveting them firmly by blows of a hammer applied upon the back of the plate. These pins are tapered a little on the face side of the mould.

The mould being thus prepared, we proceed to make a *force*, or counter-mould. In order to do this, we take several leaves of pasteboard, which we paste together one upon another, and whilst they are still moist, we apply them upon the horn mould in order to receive the impressions of the four pins, and then bore holes through the pasteboards, to correspond therewith, with a pointed instrument. We must employ at first a sufficient thickness of pasteboards so as not to endanger the pins, and add to them successively until the thickness of the force, or counter-mould, when laid underneath the press, shall exceed the length of the pins the eighth of an inch at least.

We then place the whole under the press, and squeeze them carefully, so as not to damage the pins. We also add to the thickness of the pasteboards, if necessary, and when it is become sufficient, we give a strong degree of pressure, and continue to increase it, until we have obtained a perfect impression from the mould in the pasteboards. Sometimes we are obliged to paste small pieces of paper upon the impressed side of the pasteboards, in order to fill the large cavities of the mould, which we could not otherwise accomplish; but every time that we make these additions, we should likewise paste a leaf of paper over the whole surface, in order to retain these additional parts in their places, which otherwise would be liable to become detached.

(*To be continued.*)

* The Editor has a horn mould in his possession, evidently taken in this manner, from an exquisite medal of Maria Theresa, two inches in diameter, and in which the most delicate markings of the hair, the embroidery, &c. &c. are admirably preserved. He met with this mould at a broker's shop in Somer's Town a few years since; it, no doubt, having been brought over from France by one of the emigrant priests, at the commencement of the Revolution, and was evidently intended to have been employed in embossing straw in the manner described in this article. It however also forms an excellent mould for making casts in plaster of Paris.

LIV.—*On preventing the Dry Rot in Ships.* By Mr. Edward Carey, R. N.*

Every one knows that deciduous trees are full of sap during the period, which begins in early spring, and terminates with the complete expansion of the leaves. If at this time a branch be cut off, or if a hole be bored into the trunk, an exsudation of the sap, in a greater or less abundance, will follow. The bark at this time may be stripped off the wood with ease, and in large flakes; and every part of the tree is, so to speak, bathed in moisture. A chemical analysis of sap shows it to be a watery liquor, containing some sugar, mucilage, and extractive matter. In several trees, as the birch and sycamore, the sap is sufficiently copious and saccharine to furnish a fermentable liquor, from which a weak, though perfect wine, may be made; and the sugar-maple of North America produces a sap, from which sugar is annually made in considerable quantity, by boiling it down to a proper consistence. At the fall of the leaf, the wood of a living tree is considerably dryer than it was in spring, and contains a less quantity of sugar, and other easily decomposable vegetable principles.

The old method of preparing oak timber for naval use, appears to have been, to cut down the tree in winter, and after lopping the ends of the branches, to let it remain where it fell till the next summer, without stripping the bark from it. During the spring, the buds in the bark, and those in the sprays which had not been removed, began to vegetate and grow; and in so doing absorbed, consumed, and removed a part, probably nearly the whole, of the sap which was contained in the trunk at the time of its being felled. The imperfect condition of the roads rendered it impossible to convey heavy timber along them, except in the height of summer, so that a tree grown in the weald of Sussex, or even in the remote parts of the

* From Vol. XLVII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

New Forest, often did not reach Portsmouth Yard till the second year after it had been felled. Here it was stripped of its bark, and stacked either in the open air or under cover, till by continued exposure to a free draught of air, it was seasoned, that is, dried.

During this method of management, fungous rot appears to have scarcely existed in our shipping, whether naval or mercantile.

Of late, within the last fifty years, a great increase has taken place in our navy, without a corresponding supply of oak timber of home growth; and, at the same time, the price of oak bark, for the use of the tanner, has been continually augmenting. These circumstances have led to the practice of felling timber in spring, when, from the abundance of sap, the bark is easiest stripped. But, with the removal of the bark, that vegetation which used to take place during the summer after felling, and which probably was so advantageous in seasoning the wood, is prevented. The naked wood, full of moisture, is exposed to the drying winds of spring and the heat of summer; in consequence of which it becomes shaken and injured by numerous wide clefts, occasioned by partial drying, which admit the rains and probably also the microscopic seeds of fungi to the heart of the tree. The immense demand of our dock-yards during the last half century of almost incessant war, necessarily occasioned a diminution of the time requisite for seasoning. Hence the timber employed in the construction of shipping has probably of late years been defective, not only from insufficient drying, but also from containing sugar, mucilage, &c. the elements of sap, which, when not acted upon by the living power of vegetation, are susceptible of vinous and acetous fermentation, and, finally, are resolvable into a matter, in which the seeds of fungi will grow with great vigour.

To the duration of timber so circumstanced, its situation in the hull of a ship is singularly unfavourable. The external surface, both without and within the ship, is covered

with pitch, turpentine, or paint, by which the further escape of moisture (or the process of seasoning), is entirely prevented. The other surfaces of the timber are exposed in darkness to the action of a warm, moist, stagnant air; that is, they are in a situation the most favourable for spontaneous decomposition, the rapidity of which is probably hastened tenfold by the growth of fungi, the slender roots of which penetrating into the pores of the wood, occasion the destruction of its substance to proceed even more rapidly than that of its surface.

It is well known that a saturated solution of common salt is destructive of vegetable life, even in those plants which flourish only in sea water, and a still weaker solution is fatal to all except the maritime plants. Hence it might be argued that ship timber would be secured from rot (as far as this is occasioned by the growth of fungi), by injecting its sap vessels with a solution of salt; and this treatment has been found efficacious in practice. Merchant vessels that convey salt in bulk, are not liable to fungi. A frigate, infested with fungous rot, was accidentally sunk in the Mediterranean, and when weighed again; after remaining under water for some months, was found to be free from fungi, and so continued. In the United States of America, many vessels are built of timber quite green, and in these it is by no means uncommon to fill up the spaces between the timbers with salt, and vessels so salted, it is understood, bear a higher price in the market, on account of their greater durability.

Again, it might be argued, that oil would be efficacious, by penetrating into the sap vessels of timber, and thus preventing the access of moisture: in confirmation of which it may be observed that Greenland ships, and other whalers, are not liable to fungi. Agreeable to this theory, is the practice which prevailed at Boston more than forty-five years ago, to hollow the heads of the timbers, and to fill them with oil, during the building of the ship.

The efficacy of oil, combined with salt, may be argued

from the known fact, that vessels engaged in the Newfoundland fishery, in which the salted fish are stowed in bulk, are not at all liable to fungous rot, and that the bottom of the hull of such vessels will last as long as two or three successive tops.

From these and similar facts, Mr. Carey was convinced that a mixture of oil and salt, applied to the timbers of ships, would be very efficacious in preventing rot. He also thought that it would be found useful to add to this composition a quantity of powdered charcoal, in order to increase its bulk, at small expense, without introducing any noxious ingredient, and which should have the farther advantage of being so light, as in the least possible degree to affect the buoyancy of the vessel.

In the year 1785 he built two schooners, of eighty tons each, in the Island of Cape Breton, for a Mr. Simmons, and filled up all the spaces between the timbers and elsewhere with a composition made of the before mentioned ingredients.

The next year he removed to the Gut of Canso, and there built, of green wood, fresh from the forest, a brig of 200 tons for a Mr. Williams, an American refugee. In this vessel, before he put on the plank sheers, he bored a hole in the centre of each timber-head, fore and aft, on each side, as deep as he could without injuring the treenails, keeping clear of the bolts and nails. These holes he filled up with a mixture of cod or seal oil, salt, and fine charcoal, brought to as thick a consistence as would run. The spaces between the timbers and elsewhere he filled with a similar composition, but of the consistence of mortar. The way in which it was applied was this: the space being filled with the composition, a block of wood, smaller than the space, was then laid on the surface and driven in; the compression forced the mixture into the smallest adjacent crevices, and the block was allowed to remain. Stops of wood were also inserted where required, in order to keep the whole in its place, and prevent it from slipping down.

The brig, filled in as described, was launched, and was employed in the trade between the United States and the West Indies.

In the year 1816 Mr. Carey, on his return from the West Indies, by way of the United States, proceeded to New York, where he accidentally met with Mr. Williams, the owner of the brig. This gentleman informed Mr. Carey, that the vessel which he had built for him thirty years before, was then at New York, that he had had occasion to open her a short time before, and found her as sound as on the day she was launched. He invited Mr. Carey to come on board, and allowed him to bore with a half-inch auger into any parts where he suspected decomposition might have taken place. Mr. C. accordingly did so, and found every core brought out by the auger to be perfectly sound.

As Mr. Carey had no intention at that time of making public the result of his experiment, he did not request of Mr. Williams any certificate of the facts above stated; but when, in 1827, he communicated these particulars to the Society, it was conceived by the Committee, to whom the investigation of the subject was committed, that, although they had no reason whatever to question the correctness of Mr. Carey's statement, the public would be better satisfied to have the particulars of this very interesting and important experiment substantiated by the attestation of Mr. Williams. But Mr. W. was not a resident at New York; and although Mr. Carey inserted an advertisement in the New York newspapers, as also did J. A. Yates, Esq. of Liverpool, on the part of the Society, in the newspapers both of New York and Boston, nothing could be heard of Mr. Williams till Mr. Carey learnt, some time after, that Mr. W. had died in the West Indies three years before.

It is understood that the Navy Board, at present, have the spaces between the timbers in men of war filled with a mixture of chalk, oil, and Stockholm tar, injected into the bottom of the frame by means of a forcing pump.

LV.—*On Improvements in the Art of Painting in Water-colours. By Mr.* C. J. ROBERTSON.*

Wotton House, Isleworth,
April 10, 1829.

SIR,

IN the hope of being useful to the lovers of painting, I send you a specimen of a new method of painting in water-colours, the result of experiments pursued for some years, in the hope of enabling water-colours, in some measure, to compete with oil. How far I have succeeded in producing the force and brilliancy of an oil picture, the Society of Arts will be enabled to judge, from this copy of the splendid picture of Titian, in the National Gallery; but my method possesses some peculiar advantages in durability, and in a facility of cleaning, which are, I do not hesitate to assert, superior to oil; and as also in a picture painted in this manner, not requiring a glass, as it may be cleaned with alcohol at any time, as often as you please, and without suffering the slightest injury; and every one knows, who is at all acquainted with the subject, that alcohol will instantly and entirely remove any dirt, that a picture may be subject to receive; but it is used with considerable danger to paintings in oil. I have paintings by me, which have been painted several years, and always exposed to light and air, and which, nevertheless, have not undergone the slightest change; and the method may be applied to paintings on a much larger scale, with, I have no doubt, equal success.

The painting before you (a copy of the Bacchus and Ariadne, by Titian), is painted on what is called Bristol-board, or paper, attached with glue or paste to canvass, and which is again effectually protected from the action of the atmosphere, known to corrode the canvass of oil paintings, and also from any injury arising from humidity, by attaching tin-foil, by means of paste, to the back of it.

* From Vol. XLVII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce. The Society voted its gold Isis medal to Mr. Robertson for his invention.

After drawing in the outline purely and carefully (by purely, I mean, in a single, clean, and sharp line), with a black-lead pencil, rather hard, that the black-lead may not disturb the purity of the colours, I wet the paper all over with water, in which a small quantity of ox-gall is dissolved, and then lay a foundation tint, of finely-ground blue-black* (with the usual proportion of gum arabic), to represent the shadows and half tints, laying them on in succession, and carefully adhering to the contours, without softening their edges, the first tints rather faint and covering all but the extreme lights; after I have laid in several gradations, I take a large soft brush, and plenty of water, and wash off as much as will come away, taking care always to leave the lights clean; I repeat this, washing in and washing out, till the shadows *appear* as strong as the picture is intended to be, and no more will wash off; the half tints ought to be much stronger than may appear necessary, as they lose their apparent depth of tone in a remarkable degree, when the other colours are applied. When the foundation tints are nearly dry, I then lay on the carnation tints of the flesh with *madder lake*†, which is perfectly durable, and wash off in the same manner till it is not to be removed by washing; when these are strong enough, I wash on, in a very dilute state, yellow (stone) ochre, or raw terra di Sienna; in the brown flesh, burnt terra di Sienna: this, if done decidedly and with sufficient force, will bring the flesh nearly to its effect; the stronger shadows are given with Vandyke brown, burnt umber, or raw umber, mixed with madder purple, madder brown, or Indian red, according to circumstances; these last need not be washed off again. When I have got the whole picture to as much force as it can be brought in the usual way, the whole drawing should be washed over with a thin

* For the satyrs, and browner figures, I used Vandyke brown, and the colours may be sepia, or any others that may suit the picture; but I think these three will answer every purpose.

† For the flesh of women and young persons; for others, Indian red, and Venetian red.

solution of gum tragacanth* in water, with a large brush; in doing this, care must be taken not to repeat the stroke in the same place till it is dry, and not to leave it in masses any where, as that would occasion a streakiness. The best way of doing it is, to lay it on in parallel strokes, the latter ones always touching the edges of the former ones; this operation may be repeated several times, allowing the paper to dry in the intervals, and it affords an excellent surface for working on, and will bring out the colours in a surprising degree, and yet without giving the smeared appearance, like the traces of snails, that gum arabic gives. The picture must now be worked up to its greatest strength, always covering it with the solution of gum tragacanth, till it appears finished; it must then be varnished over with a solution, in spirit of wine, of isinglass previously soaked in distilled water. This will increase the strength, brilliancy, and durability of the picture, and as dry isinglass is not soluble in spirit of wine, except at the boiling temperature, so it is evident that it may be cleaned with cold alcohol with impunity.

The trees in the specimen are painted in body colours, to show how capable they are of being united with the other parts; and indeed any part of the picture might have been painted in body colours. In general, I paint all except the flesh in body colours, varnishing it first with the solution of gum tragacanth, and finally with isinglass. By using all the colours separately and unmixed, except for the dark shadows, the colours appear so much brighter, that none of the bright colours that are at all doubtful need be used: in this drawing, with the exception of the madder colours, they are all earths; no yellow brighter than yellow ochre being necessary. The lights will thus always maintain their purity, and the dark tints their full depth, which is not the case in oil, where the former grow darker, and the latter become meally. The varnish necessary to bring out the dark tints again, becomes gradually opaque, and

* It is better also to add a small quantity of gum arabic to it.

must, after a time, be taken off, with considerable danger to the picture, even in skilful hands.

This method is, therefore, particularly calculated for perpetuating valuable pictures in copies, as I am thoroughly persuaded it undergoes no change at all. I shall be happy to give any further explanation, either personally or by letter, and remain, Sir,

Your obedient servant,

CHARLES JOHN ROBERTSON.

A. AIKIN, *Esq. Sec. &c. &c.*

LVI.—*On the Art of the Plumassier**.

THE plumassier collects and prepares the delicate feathers of birds, and gives them the most brilliant colours, in order to vend them to the embroiderer, and the manufacturer of artificial flowers, who introduce them into their embroideries, and form them into bouquets and garlands, to add to the elegancies of dress and furniture, according to the tastes indicated by fashion.

The plumassier only employs the feathers of the ostrich, the heron, the pea-cock, the swan, the goose, and the cock; these he prepares, and disposes in a fit manner to adorn our hats, robes, &c.; he also makes *aigrettes*, and an infinity of other objects. The workman who forms the feathers for these uses, is termed a *panachier*. All the kinds of feathers which possess great brilliancy, extent, and fineness, are also employed in a great variety of circumstances, although those are preferred which we have above mentioned.

We shall now proceed to indicate the processes employed in preparing the plumes of the ostrich, the others being prepared in the same manner.

There are many qualities to be distinguished in the feathers of the ostrich, those of the male are the whitest and finest. We choose, in preference, those from the back, and

* From the *Dictionnaire Technologique*.

from underneath the wings; also those which come from the ends of the wings; and, lastly, those of the tail, which are termed *bouts de queue.*

The down is the feathers which cover the other parts of the body, and whose length may vary from four to twelve and fifteen inches. This down is black in the males, and grey in the females, and takes the names of the *petit-gris,* and *à pointe plate.*

The finest white plumes from the females, are always grey towards the ends of their fibres, which much diminishes their splendour, and lessens their value.

Independently of these feathers, they also strip from the neck and thighs of the ostrich, those tubes of a soft consistence, like the skin, which contain feathers, which have not yet acquired their full length; these are strung upon a thread, as they are much slenderer than the tubes which are afterwards formed. Nevertheless, these latter are also used.

The plumes of the ostrich furnished in commerce, come from Algiers, Tunis, Alexandria, Madagascar, and Senegal. We have named them in the order of their qualities; the first are the most esteemed. The rough feathers are sold in boxes, each containing a hundred.

Preparation.—On opening the boxes, amongst those feathers of the finest quality, they select those whose stems have a soft consistence; they then extend their fringes, place them one upon another, and rub them carefully with the palm of the hand, in order to perfectly detach their threads.

They then tie these feathers, one by one, to the same end of a thread, separating the one from the other by a double knot; they thus place twenty-five on each end of the thread, and which then takes the name of filet. The filet which bears the tail feathers, or *les bouts de queue,* contains a hundred, attached two by two. Twelve filets form what is termed *une poignée* (a handful).

Removing the Grease.—They dissolve one hundred and

twenty-two grammes (four ounces) of white soap, cut into small bits, in four litres of moderately warm water, placed in a large basin; they then agitate the water well, with a bundle of osier twigs; and when it is all in a froth, they plunge two threads of feathers into it, and which they rub well with the palms of the hands, during five or six minutes. After this, they take two other threads of feathers, and treat them in the same manner; and proceed thus with the others, until they have well soaped all the *poignée*. The bath is then considered old, but, nevertheless, serves, by adding another litre of water to it, and again heating it, to prepare other *poignées*. They give to each *poignée* two old baths, and three new ones.

After soaping, they wash the threads of feathers, six by six, in two successive waters. All the baths should be so hot, that the hand can scarcely support the heat

Bleaching.—This operation consists of three different manipulations.

1st. They steep the feathers, six threads at a time, in three litres of hot water, just below the boiling heat, which holds in solution a demi-kilogramme of Spanish white (fine whitening); they then agitate the water strongly, leaving the feathers therein for a quarter of an hour, and stirring them from time to time, to prevent the white from precipitating. They then finally wash these six threads in three different waters.

2nd. They blue the feathers in cold water, in which they have dissolved a little indigo, tied up in a fine linen cloth. This solution is but very slightly coloured; they pass the feathers through this bath, after they have been well washed.

3rd. The sulphuring is effected in the same manner as in bleaching straw, and as described in the present number. Finally, they are dried, by hanging the threads of feathers upon cords. They take care, during the drying, to take the stems of the feathers in the hand, and strike the feathers upon a smooth table, in order perfectly to detach the

fibres of their fringes. This operation must be performed whilst the feathers are a little moist, lest, if left till they become dry, they might risk the breaking and damaging them.

These various preparatory manipulations being terminated, they proceed to finish the feathers, which consist in dressing, assorting, curling, dyeing them, &c., as we shall now indicate.

Dressing.—After cleaning the feathers, and when they are become quite dry, they are detached from the threads, and each are passed between the fingers, from their tops to their stems, each one, singly, in order to separate their fringes, and dress each side of them. They then clip with scissars, the extremities of the fringes of those feathers which are of the second quality. They also pare off, with a sharp knife, having a strong blade, which will not bend, a portion of each side of the rib of the feather. And they likewise shave or scrape off, by the help of a slip of glass, of a rounding or circular shape on its edge, as much as possible of the rib of the feather, resting the feather upon a piece of pasteboard, in order to render the feather supple and light, and assist the floating in the air. They only use the rounded part of the glass, in order to avoid the risk of damaging the fringes of the feather; and this is a point which more especially demands all their attention.

Assorting.—Those feathers of the same quality, are also classed according to the uses for which they are designed. They are often obliged to bend a feather; in order to do which, they pass a needle and thread between the fringe, all along one side of it, taking care that they do not entangle the fringe between the loops in the thread. They secure each turn of the thread by a knot, and thus proceed, without cutting the thread, until they have reached the end of the feather.

Curling.—The feathers would not have an agreeable appearance, unless their fringes were curled. In order to perform this operation, they sometimes employ a blunt-edged

knife, the handle of which is enveloped either in a piece of cloth, or of leather, in order that it may not turn in the hand. They carefully draw out the filaments of the fringes between the thumb and the knife, and repeat the operation several times with each filament, until it curls like the hair. At other times, they support four or five of the filaments together, upon the thumb-nail of the left hand, and pass the knife forcibly over them, so as to rub them, and thus cause the fringe to turn back or curl to the middle of the feather, and which change from its natural position, renders its appearance still more agreeable.

Dyeing the feathers black.—Those feathers which the workmen class under the term down, and which, in their language, they consider as being black, are, however, only of a light brown colour. This natural colour is neither pleasant to the eye, nor well defined; and, accordingly, they are dyed black. In order to do this, they attach five or six to a thread, in the manner above described, and then prepare a dyeing-bath. For every ten kilogrammes of the feathers to be dyed, they make a strong decoction of twelve kilogrammes and a half of log-wood, cut small, in a sufficient quantity of water. After six hours boiling, they withdraw the log-wood, and throw into the bath a kilogramme and a half of sulphate of iron (green vitriol), and, at the end of fifteen or twenty minutes ebullition, they either withdraw the boiler from the fire, or, which is better, pour off so much of its contents as to leave only about two litres of the dye within it, and then extinguish the fire. They then plunge into it a handful of the feathers, and stir the whole with strong wooden staves, when they leave the feathers to steep; they then put in another handful, throw in two litres of the dye-bath, and again agitate it; they thus proceed in the same manner, until all the feathers are put in which are to be dyed. When the whole are well steeped, they leave them to macerate for two, and sometimes for three, days.

These feathers had been previously freed from their oil

or grease, in an alcaline lye, each thread of feathers singly. This lye is sometimes formed of a fourth part of a litre of alcaline lye, and sometimes of boiling water and a little soap. They are soaped three times in new baths, and when they feel soft to the touch, they are washed in pure water until they become quite clean, and are then dried in the same manner as the white feathers.

The white feathers are very difficult to dye of a good black, and the dye is liable to change. The citrate or the pyrolignate of iron are much better for this purpose, than the sulphate of iron, which always changes to a brown.

For the other colours, they take those feathers, which have previously been bleached, chusing those which are whitest for the finest and most brilliant colours. Some of the plumasiers have tried the chlorate of lime for this purpose, but did not find it good to use, and followed the ancient process, by means of exposing the feathers to the dew and to the sun, in preference. They cut the tubes or quills of the feathers into the form of a tooth-pick, and stick them one by one into the turf, leaving sufficient space between them for them to become well impregnated with the dew, and to receive the influences of the air and the sun in the most perfect manner. To perform this bleaching in the above manner, they leave them exposed to the dew for fifteen days. After this process, they employ the following:

For Rose Colour.—A cold bath of safranum, to which they add a little citron juice.

Coarse Red.—A bath of Brazil-wood, used boiling hot, after having previously passed the feathers through an alum bath.

Crimson.—The feathers are first dyed a coarse red, and then passed through a bath of orseille.

Prune de Monsieur.—Having dyed the feathers a coarse red, they are passed through an alcaline bath.

Blues, of every shade.—The same solution of indigo is

here used, as is already described, for dying straw, in the present Number.

Yellow.—After aluming the feathers, they are passed either through a bath of terra merita, or one of woad.

From the three colours, red, blue, and yellow, we obtain the other compound colours, green, violet, lilac, and orange. By dyeing the feathers first yellow, and then blue, we obtain a green; the red, afterwards dyed blue, affords the violet or lilac; the yellow, afterwards dyed red, or rose colour, gives the orange. These shades may be varied according to the strength of the baths, or as we leave the feathers for a longer or a shorter time in them.

Ponceau.—This is the most difficult colour to dye. We dye an orange in a bath formed of rocou (anatto), dissolved in an alcaline lye, and then pass the feathers many times through another, formed by boiling scarlet wool. We throw into the first rose-coloured bath the juice of citrons; into the second, brandy; into the third, alcohol at thirty-four degrees; and add pure nitre to the fourth bath, and often to the fifth. This receipt, indeed, appears to us rather empirical; nevertheless we give it, as it is that which is mostly used by the plumassiers, although not by others. L.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since February 27, 1830.

To John Braithwaite, and John Ericsson, of the New-road, in the county of Middlesex, engineers; for an improved method of manufacturing salt. Dated February 27, 1830.—To be specified in two months.

To Enoch William Rudder, and Robert Martineau, of Birmingham, in the county of Warwick, cock-founders; for certain improvements in cocks, for drawing off liquids. Dated February 27, 1830.—In six months.

To Charles Random, Baron de Berenger, of Target-cottage, Kentish-town, in the parish of St. Pancras, in the county of Mid-

dlesex; for certain improvements in fire-arms, and in certain other weapons of defence. Dated February 27, 1830.—In six months.

To William Grisenthwaite, of Nottingham, esquire; for an improved method of facilitating the draught or propulsion, or both, of wheeled-carriages. Dated February 27, 1830.—In six months.

To Henry Hirst, of Leeds, in the county of York, clothier; for certain improvements in manufacturing woollen cloth. Dated February 27, 1830. In six months.

To Moses Poole, of the patent office, Lincoln's-inn, gentleman; who in consequence of a communication made to him by a certain foreigner residing abroad, is in possession of a certain combination of, or improvements in springs, applicable to carriages and other purposes. Dated February 27, 1830.—In two months.

To Joseph Chesseborough Dyer, of Manchester, in the county of Lancaster, patent card manufacturer; who in consequence of improvements made by himself, and communications made to him by a certain foreigner residing abroad, is in possession of certain improvements on and additions to machines or machinery, to be used and applied for conducting to, and winding upon spools, bobbins, or barrels, rovings of cotton, flax, wool, or other fibrous substances of the like nature. Dated February 27, 1830.—In six months.

To William Griesenthwaite, of Nottingham, Esq.; for certain improvements in steam-engines. Dated February 27, 1830.—In six months.

To Robert William Sievier, of Southampton-row, Russel-square, in the parish of St. George, Bloomsbury, in the county of Middlesex, sculptor; for certain improvements in the construction of rudders, and in navigating vessels. Dated February 27, 1830. —In six months.

To Simon Thompson, of Great Yarmouth, in the county of Norfolk, mariner's compass maker; for certain improvements in piano fortes. Dated February 27, 1830.—In six months.

To William Howard, of Rotherithe, in the county of Surry, iron manufacturer, one of the people called Quakers; for certain improvements in the construction of wheels for carriages. Dated February 27, 1830.—In six months.

To Phillip Chelwell De la Garde, of the city of Exeter, gentleman; for certain improvements in apparatus, for fidding or un-

fidding masts, and in the masting and rigging of vessels. Dated February 27, 1830.—In six months.

To Thomas Prosser, of the city of Worcester, Architect; for certain improvements in the construction of window sashes, and in the mode of hanging the same. Dated March 6, 1830.—In six months.

To Thomas Richard Guppy, of the city of Bristol, sugar-refiner; for a new apparatus for granulating sugar. Dated March 6, 1830. —In six months.

To Ralph Stevenson, of Coleridge, in the county of Stafford, potter; for improvements in machinery for making from clay, or other suitahle materials, quarries, bricks, tiles, and other articles. Dated March 6, 1830.—In six months.

To James Ramsay, and Andrew Ramsay, both of Greenoch, in North Britain, cordage and sail cloth manufacturers; and Matthew Orr, of Greenoch, aforesaid, sail-maker; for an improvement in the manufacture of canvas and sail cloth for the making of sails. Dated March 20, 1830.—In six months.

To George Scott, of Water-lane, in the city of London, Engineer; for certain improvements on, or additions to windlasses, and relative machinery, applicable to naval purposes. Dated March 20, 1830. —In six months.

To John Alexander Fulton, of Lawrence Poultney-lane, Cannon-street, in the city of London, merchant; for an improvement in the preparation of Pepper, Dated March 20, 1830.—In six months.

To William Erskine Cochrane, esquire, of Regent-street, in the county of Middlesex; for an improvement or improvements, on his patent cooking apparatus. Dated March 20, 1830.—In six months.

To Benjamin Rotch, of Furnival's inn, in the county of Middlesex, barrister at law; for improved guards or protections for horses legs, and feet, under certain circumstances. Dated March 20, 1830.—In six months.

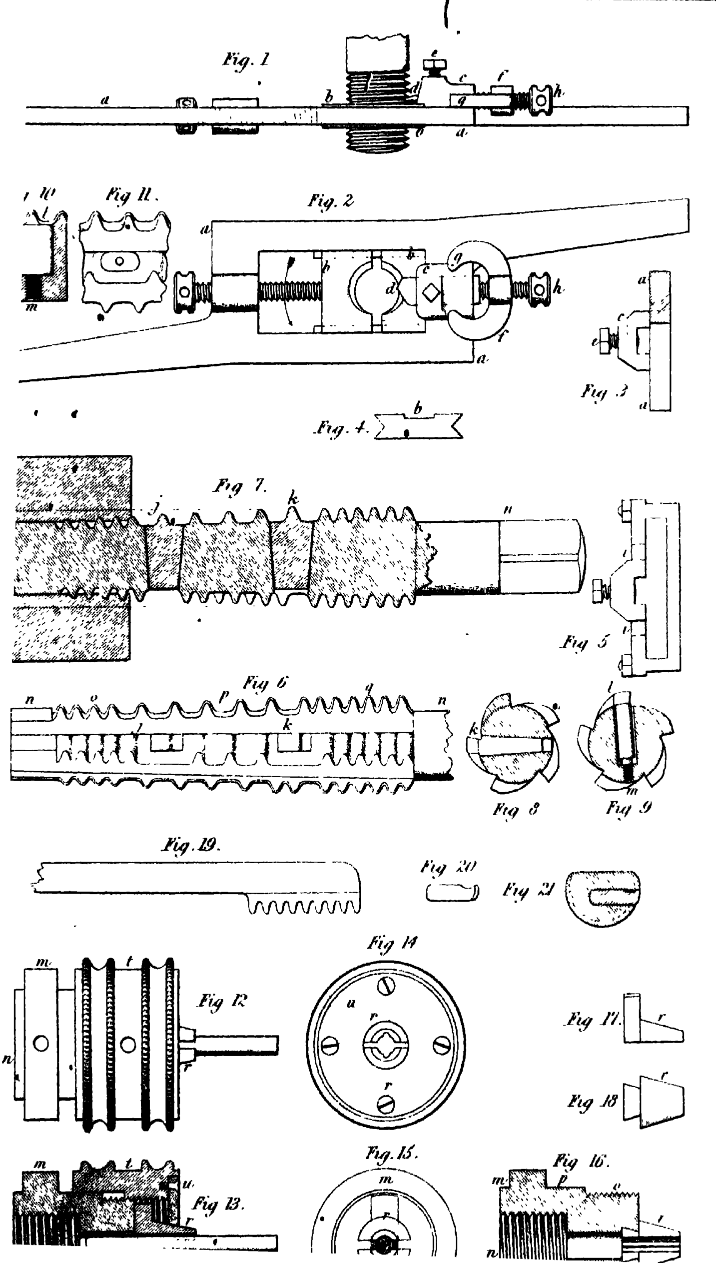
Fig. 1
Fig. 2
Fig 3
Fig. 4.
Fig 5
Fig 6
Fig 7.
Fig 8
Fig 9
Fig 11.
Fig 12
Fig 13.
Fig 14
Fig. 15.
Fig 16.
Fig 17.
Fig 18
Fig. 19.
Fig 20
Fig 21

GILL'S

TECHNOLOGICAL & MICROSCOPIC*

REPOSITORY.

LVII.—*On Improvements in Cutting Screws and Screw-Nuts. By Mr.* James Jones, *Engineer*†.

WITH FIGURES.

Well Street, Wellclose Square.
London, March 10, 1828.

SIR,

I beg leave to submit to the notice of the Society of Arts, &c., some alterations in the construction of dies and screw-taps, which materially diminish the labour requisite for tapping large screws and nuts.

I am, Sir, &c. &c.

A. Aikin, *Esq. Sec. &c., &c.* J. Jones.

The ordinary form of taps for producing the spiral groove or thread in screw-nuts, is that of a circle, of which four

* We have now for upwards of two years made a point of inserting the valuable monthly communications on the microscope, and on entomology, by our friend Thomas Carpenter, Esq. and likewise devoted our plates chiefly to microscopic subjects, most of them indeed being drawn from the objects themselves, as viewed in his excellent microscope for opaque and transparent objects; fearing, that such another opportunity of enriching our work, with a series of new and original microscopic delineations might never again occur, and we now rejoice that we availed ourselves of the facilities he so kindly afforded us; as, from Mr. Carpenter's removal to a distance from the Metropolis, we shall lose the future opportunity of so conveniently doing so. It is indeed true, that Mr. William Tulley has obligingly offered us the use of his superior achromatic microscopes, but he resides at Islington, and can therefore only be occasionally resorted to, and, although, indeed, we always have our own Varley's and Adams's microscopes, and our own set of objects at hand; yet, the microscope can now be but a secondary object with us, instead of being, as latterly, a principally one; although we shall certainly occasionally devote a portion of our work, to articles on this highly interesting subject.

† From vol. XLVII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

segments are filed off, leaving four smaller intermediate segments remaining; the parts corresponding to the chords of the different segments, forming very obtuse edges, by which the metal in the nut is squeezed or rubbed out. It is customary to use two taps,—a *taper*, or slightly conical one, with which the operation of tapping is commenced; and a *plug*, or cylindrical one, to equalise the hole, and make the thread perfect.

The common tap requires to be worked into the hole in the nut, by an alternate advancing and receding motion; its cutting being of so imperfect a kind, that the power requisite to urge the tap forwards, with a continually advancing motion, would be sufficient to wring the neck of the tap off, the resistance being greater than the strength of the steel can overcome.

The altered form of the tap which I have adopted, with very satisfactory results, is a combination of both the taper and plug taps, the part next the point being conical, and the upper part cylindrical; and, to prevent the necessity of drawing the tap out of the nut, when it is tapped, the head of the tap is made less than the bottom of the thread, so that it drops through of its own accord. The tap is fluted, with four or more grooves formed along it, one side of each of which is in a line pointing to the centre; thus affording, in a cross-section of the tap, a form somewhat similar to that of a ratchet-wheel. About one-third of the threads have their tops filed down, to diminish the quantity of surface in contact, by which much labour is saved, as the greater part of the power requisite for tapping in the common way, is expended in overcoming the friction, and not in cutting away the superfluous metal in the nut. This answers perfectly well for nuts not exceeding one and three-quarter inches in diameter; but for larger ones, as those of two or three inches, for instance, I have found it advisable to insert a cutter in the body of the tap, just at that part where the cone terminates; and by the action of which cutter, nearly the whole of the metal is cut out; the upper

or cylindrical part of the tap having nothing to do but to equalise and smoothen the thread. With this arrangement, I have had large nuts tapped at an expense not exceeding half the usual cost; for the operation is performed by a lesser number of hands, and more expeditiously, as the tap is inserted into the nut, and the men with the tap-wrench then merely walk continually round it, until the tap drops through, when the nut is completed, and without the use of the plug-tap.

In screwing large bolts, I have experienced considerable advantage from clamping a cutter upon the face of the die-stock, which, after the dies have got a good lead on the bolt, takes out the metal very rapidly, and with very little labour, the operation being merely the converse of the preceding*.

These alterations, and additional cutters, produce very advantageous effects, as I have experienced in the manufacture of a large quantity of screwed bolts and nuts, which were cut by the means here described.

J. Jones.

Reference to the Figures.

In plate V. figs. 1, 2, and 3, *a a* is the die-stock; *b b*, the dies; *c*, a boss, perforated to receive the cutter *d*; *e*, a screw, to bind it tight; a moveable clamp-piece *f* lays hold of the boss with its hoops *g g*; it also contains the adjusting screw *h*; this boss may be removed, and the cutter also, or else be drawn back, whilst running the bolt through the dies, in order to obtain a sufficient lead; the cutter is then to be advanced, to do the remainder of the work, by turning the screw *h*. Sinking the face of the die a little, as shown at *b*, fig. 4, holds the cutter more perfectly. To make the cutter, the tap is held in the dies; and when the cutter is nearly fitted, it is urged against the tap by the

* In our *Technical Repository*, where we have given numerous improved modes of cutting screws and nuts, our readers will recollect Mr. Peter Keir's introduction of a cutter, to assist the dies, in cutting square-threaded screws. Editor.

screw *h*; and by the screw *e* being also made to hold it moderately tight down, and it being turned round against the tap, the perfect figure is given to it. The face of the cutter is made flat, and its back is filed or ground away to clear, just like a turning tool. Fig. 5 shows a clamp, adapted for applying such a cutter to old stocks, that are not provided with the means of holding it; *i i* are dovetailed gaps, for holding a clamp-piece *f*.

Fig. 6 is a tap; figs. 7 and 8, sections of it; *j*, *k*, two cutters, fitted into taper holes, made in the tap to receive them; these cutters are formed whilst making the tap; the teeth are then indeed flush with the tap thread, but they are afterwards made to rise a little above it, by introducing bits of writing-paper into the holes.

Figs. 9 and 10 are sections of a larger tap, containing a cutter *l*, the body of which is parallel; fig. 11 is a portion of the tap, showing the parallel cell into which the cutter is fitted; *m*, a screw, placed at the bottom of the cell, to raise the cutter. I do not use moveable cutters in taps below inch and quarter size; but, in all cases, I reduce the tap into a series of cutters of the best form, they having flat faces, radiating from the centre of the tap; five flutes, made the whole length of the tap, answer best, as shown in figs. 6, 8, and 9; thus taking away full two-thirds of its circumference, one-third being sufficient for the spiral guidance: but even this is not a sufficient reduction; for if four threads only were in the hole, there would still be twenty cutters, and these would require twenty times the force which a man uses with a single turning-tool of a similar size; and the cutters are less worn by making a decided cut, than by mere scraping. I therefore remove half of these cutters along the middle of the tap; but, as beginning the hole is easy, and the guidance and lead of the thread are then most wanted, so I use the plain cylindrical part *n* to make the tap begin to cut upright, or straight with the hole; and leave the three or four first turns of the cutters *o* to form the lead, and draw the tap in. I then

remove every alternate cutter along the portion *p*, leaving the parallel or cylindrical portion *q* undisturbed. For tapping deep holes, two-thirds of the cutters may be removed with advantage. I sometimes use but one adjusting cutter; but two divide the labour if one leaves the hole just as the other is entering it.

LVIII.—*On a simple method of making large Screws.*

About forty years since, an ingenious smith, at Birmingham, named Anthony Robinson, was employed by the late eminent Matthew Boulton, Esq., of the Soho, to make him a large wrought-iron screw for a press, of about six inches in diameter, and seven feet in length; and not having the assistance of any of the modern machines now in such frequent use for screw making, he was of course obliged to depend upon his own resources. Having then turned the body of the intended screw cylindrical, he fitted a piece of paper accurately around it; and then again extending it, he drew a number of parallel and equi-distant lines obliquely across it, from side to side, with ink, at a proper angle for the number of threads in the screw, which was to be a triple threaded one. This paper he then cemented firmly upon the cylindrical body of the intended screw, and, with a conical pointed punch, and a hammer, he pricked out the course of the lines, through the paper, upon the surface of the iron cylinder, and then removed the paper. He then connected the points so pricked, by tracing a file along their courses, and thus formed a series of regular helical lines along the superficies of the cylinder, being indeed the outlines of the threads of the screw. He next proceeded to cut away with a hammer and cold chisels, the iron between all the threads, until he got to a sufficient depth to afford a lead. He then erected a strong horizontal beam of wood, upon two firm upright posts, driven into the earth; and upon one of the upright sides of this beam, he affixed, by means of screws and nuts, a stout

wrought-iron cylindrical box, larger in its internal diameter than the screw, and having flat wings on both sides of it to receive the screws; and suspending the screw vertically within it, and also closing its lower part around the screw with moistened clay, he poured melted lead, hardened with tin, around the screw, until it filled up the space between it and the surrounding iron box, and thus formed a sort of female screw, of sufficient power to guide the screw accurately upwards and downwards within it, when it was turned round by persons beneath, with the help of a proper lever. He then fitted to the iron box the necessary guiding staples, and binding and adjusting screws, to contain cutters, by means of which, he soon brought the threads of the screw to a proper figure, and a perfect regularity. And thus, and in this simple and effectual manner, he succeeded in making what was, at that period, thought an extraordinary piece of workmanship.

Many occasions may occur, where these hints may prove of essential service in cutting large screws; and we have therefore thought they might be a useful addition to the other article on screw making contained in our present number.

A female screw or box may be formed to this screw in the manner of making the hollow screws or boxes for vices, as described in that article in the present number, and which may thus render the screw fit for use in a coining or other press.

LIX.—*On a Self-Centering Lathe Chuck.* *By Mr.* S. MORDAN, *Castle Street, Finsbury**.

WITH FIGURES.

MR. MORDAN is a celebrated manufacturer of patent ever-pointed pencil-cases, and other similar articles, and has therefore occasion to pass a large quantity of wire through

* From vol. XLVII. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce. The Society voted its large silver medal to Mr. Mordan, for this valuable invention.

the lathe. For this purpose, the wire, previously cut into lengths, must be chucked quite centrally, in order to be drilled or pivoted, or to have the ends turned convex or concave, &c. It is found, however, that wire, even in the same coil, varies considerably in thickness; and as this difference, whenever it happens, requires a fresh adjustment of the chuck, the result is a great loss of time, there being no chuck that can be depended on capable of correctly accommodating itself to the various sizes of wire. Neither the right and left handed chuck, nor the spring chuck, will answer this purpose. In order to obviate this difficulty, which, by its frequent occurrence, soon rises to a serious amount, Mr. Mordan invented the chuck about to be described. He found it fully to answer the end that he had in view, communicated it to some of his friends professionally conversant with fine turning, and receiving from them ample testimony of the use and efficiency of the invention, laid it before the Society of Arts, of which he is a member, in order that it might be freely offered to the public, through the medium of their Transactions.

In plate V. fig. 12 is a view of the chuck, with a piece of wire fixed in it, ready for turning; fig. 13 is a section of the same; *m* is the body of the chuck, having on its outside a raised broad ring, in which is bored a hole, for receiving the stem of a tightening and loosening lever; *rr*, a pair of steel jaws, in which the wire is held; and *t* is the cap or cover, by screwing which, the jaws are adjusted, so as to bring any cylindrical wire placed within them accurately in a line with the axis of the chuck. This cap has also a hole in it to receive the stem of the fastening and loosening lever. Fig. 16 is a section of the body of the chuck, and one of the jaws in it; and figs. 17 and 18 are the jaws detached from the chuck; *n*, figs. 13 and 16, is a hollow screw, by which the chuck is screwed upon the lathe mandrel; *o o*, fig. 16, is an external screw, surrounding the outer end of the body of the chuck; the intervening cylindrical space *p*, between it and the raised ring,

being left plain. In the circular end *q* (shown more distinctly in the end view, fig. 14), is cut a dove-tailed groove, in which the jaws *r r* slide. Each of these jaws is made of steel, and in the form of half a truncated cone, with a sliding dove-tail at the bottom of each, which enters the dove-tailed groove made across the circular end of the chuck. Figs. 17 and 18 are front and side views of one of the jaws. The cap *t* has a hollow screw cut within it, which fits the external screw *o o*, fig. 16; and likewise a plain cylindrical part, which exactly fits the cylindrical part *p* of the body of the chuck, and greatly assists in steadying the cap behind*; and at the end of the cap is screwed or riveted a thick steel plate *u u*, figs. 13 and 14, the centre of which is pierced with a conical hole, just wide enough to allow the jaws to project through it about half their length.

In order to use this chuck, the cap is taken off, and the two jaws are slid from the centre, to admit the wire between them; the jaws are then closed upon the wire, and the cap is screwed on; during this latter operation, whatever eccentricity might at first have existed in the position of the jaws, is corrected by the pressure of the conical hole in the steel plate, upon the conical sides of the jaws; so that the mere act of screwing on the cap, necessarily brings the cylinder of wire placed between the jaws into the true centre of the chuck.

This chuck is also well adapted for holding wire to be cut and turned into small screws; as well as for receiving and actuating drills of all sorts and sizes in the lathe; and thus entirely saving the time which is generally lost in adjusting them truly.

To the workman desirous of making this chuck, the following directions will be of use:—Take a piece of brass, or

* In a similar manner to the chucks of Mr. Saxton's American lathe, described in vol. V. page 105; and indeed Mr. Mordan, on seeing it, stated, that he had also employed a similar means. We think the whole chuck would be improved, by adopting that manner of fitting it upon the lathe-mandrel. EDITOR.

gun metal, one and three-quarter inches long, and the same in diameter; turn a hollow screw in one end of it, and fix it firmly on the mandrel of the lathe, so that there shall not be the least degree of shake (see the preceding note, EDIT.); then, cut an external screw on the other end of it, half an inch long, also leaving a plain cylindrical surface, of the same length, between the screw and the raised ring in which the lever-hole is made. In and across the external flat end of this piece of brass, cut a dove-tailed groove; then take a flat piece of steel, having a cylindrical stud, five-eighths of an inch thick, and the same in height, projecting from the middle of its upper face; shape and adjust this piece of steel so that it shall fit the dove-tailed groove accurately, and yet slide easily in it; then turn the cylindrical stud into the figure of a truncated cone, five-eighths of an inch wide at bottom, and one quarter of an inch at top. Next, take a collar of brass, or gun-metal, and cut in it a hollow screw, to fit the external one formed upon the first piece of brass; also let into the outer end of this collar, a disc of sheet steel, one and three-quarter inch in diameter, and one-eighth of an inch thick, and fix it in its place by screws or rivets; then pierce a hole through the centre of it, of a conical form, so as to fit the conical upper half of the steel stud. Next, screw the cap tight on the stud, and bore a hole truly in the axis of the chuck, through the stud, and continue it, till it reaches the screw of the lathe mandrel; then take out the steel slider, and enlarge the hole drilled in the axis of the chuck, until it will receive easily the thickest wire that is wanted to be turned. Lastly, divide the steel slider, by a transverse cut, into two jaws, and angle them within, so that they shall hold firmly, whatever work may be put between them.

LX.—*On the advantages attending the Division of Labour, and the employment of Machinery. By the celebrated Dr.* A Smith*.

"The annual labour of every nation is the fund which originally supplies it with all the necessaries and conveniences of life which it annually consumes, and which consist either in the immediate produce of that labour, or in what is purchased with that labour from other nations.

"According, therefore, as this produce, or what is purchased with it, bears a greater or smaller proportion to the number of those who are to consume it, the nation will be better or worse supplied with all the necessaries for which it has occasion.

"But this proportion must, in every nation, be regulated by two different circumstances; first, by the skill, dexterity, and judgment with which its labours are generally applied; and, secondly, by the proportion between the number of those who are employed in useful labour, and that of those who are not so employed. Whatever be the soil, climate, or extent of territory, of any particular nation, the abundance or scantiness of its annual supply must, in that particular situation, depend upon these two circumstances.

"The abundance or scantiness of this supply too seems to depend more upon the former of those two circumstances, than upon the latter. Among the savage nations of hunters and fishers, every individual who is able to work, is more or less employed in useful labour, and endeavours to provide, as well as he can, the necessaries and conveniencies of life for himself, or such of his tribe as are either too old or too young, or too infirm to go a hunting or fishing. Such nations, however, are so miserably poor, that from mere want, they are frequently reduced, or at least think themselves reduced, to the necessity sometimes of directly destroying, and sometimes of abandoning, their infants, the old people, and those afflicted with lingering

* From his "*Wealth of Nations.*"

diseases, to perish with hunger, or to be devoured by wild beasts. Among civilized and thriving nations, on the contrary, though a great number of people do not labour at all, many of whom consume the produce of ten times, frequently of a hundred times, more labour than the greater part of those who work; yet the produce of the whole labour of the society is so great, that all are often abundantly supplied; and a workman even of the lowest and poorest order, if he is frugal and industrious, may enjoy a greater share of the necessaries and conveniences of life than it is possible for any savage to acquire.

"The causes of this improvement in the productive powers of labour, and the order according to which it is produced, and is naturally distributed among the different ranks and conditions of men in the society, make the subject of this inquiry.

"The greatest improvement in the productive powers of labour, and the greater part of the skill, dexterity, and judgment with which it is any where directed or applied, seem to have been the effects of the division of labour.

"The effects of the division of labour, in the general business of society, will be more easily understood, by considering how it operates in some particular manufactures. It is commonly supposed to be carried farthest in some very trifling ones; not perhaps that it really is carried farther in them than in others of more importance; but in those trifling manufactures which are destined to supply the small wants of but a small number of people, the whole number of workmen must necessarily be small; and those employed in every branch of the work, can often be collected into the same workshop, and be placed at once under the view of the spectator. In those great manufactures, on the contrary, which are destined to supply the wants of the great body of the people, every different branch of the work employs so great a number of workmen, that it is impossible to collect them all into the shop. We can seldom see more, at one time, than those employed in one single

branch. Though in such manufactures, therefore, the work may be really divided into a much greater number of parts than in those of a trifling nature, the division is not near so obvious, and has accordingly been much less observed.

"To take an example, therefore, from a very trifling manufacture, but one in which the division of labour has been very often taken notice of, the trade of the pin-maker; a workman not educated to this business (which the division of labour has rendered a distinct trade), nor acquainted with the use of the machinery employed in it (to the invention of which the same division of labour has probably given occasion), could scarce, perhaps, with his utmost industry, make one pin in a day, and certainly could not make twenty. But in the way in which this business is now carried on, not only the whole work is a peculiar trade, but it is divided into a number of branches, of which the greater part are likewise peculiar trades. One man draws the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations, to put it on is a peculiar business, to whiten the pins is another; it is even a trade by itself to put them into the paper; and the important business of making a pin, is, in this manner, divided into about eighteen distinct operations, which, in some manufactories, are all performed by distinct hands, though in others the same man will sometimes perform two or three of them. I have seen a small manufactory of this kind, where ten men only were employed, and where some of them consequently performed two or three distinct operations. But though they were very poor, and therefore indifferently accommodated with the necessary machinery, they could, when they exerted themselves, make among them about twelve pounds of pins in a day; there are in a pound upwards of four thousand pins of a middling size; those ten persons, therefore, could make among them upwards of forty-eight thousand pins in a day; each person, therefore, making a tenth part of

forty-eight thousand pins, might be considered as making four thousand eight hundred pins in a day; but if they had all worked separately and independently, and without any of them having been educated to this peculiar business, they certainly could not each of them have made twenty, perhaps not one, pin in a day; that is, certainly not the two hundred and fortieth, perhaps not the four thousand eight hundredth, part of what they are at present capable of performing, in consequence of a proper division and combination of their different operations."

"This great increase in the quantity of work, which, in consequence of the division of labour, the same number of people are capable of performing, is owing to three different circumstances; first, to the increase of dexterity in every particular workman; secondly, to the saving of the time which is commonly lost in passing from one species of work to another; and, lastly, to the invention of a great number of machines, which facilitate and abridge labour, and enable one man to do the work of many. First, the improvement of the dexterity of the workman, necessarily increases the quantity of work he can perform; and the division of labour, by reducing every man's business to some one simple operation, and by making this operation the sole employment of his life, necessarily increases very very much the dexterity of the workman. A common smith, who, though accustomed to handle the hammer, has never been used to make nails, if upon some particular occasion he is obliged to attempt it, will scarce, I am assured, be able to make above two or three hundred nails in a day, and those too very bad ones. A smith who has been accustomed to make nails, but whose sole or principal business has not been that of a nailer, can seldom, with his utmost diligence, make more than eight hundred or a thousand nails in a day. I have seen several boys, under twenty years of age, who had never exercised any other trade but that of makings nails, and who, when they exerted themselves, could make each of them upwards of two thou-

sand three hundred nails in a day. The making of a nail, however, is by no means one of the simplest operations. The same person blows the bellows, stirs or mends the fire, as there is occasion, heats the iron, and forges every part of the nail. In forging the head, he is obliged to change his tools. The different operations into which the making of a pin or of a metal button, is subdivided, are all of them much more simple; and the dexterity of the person, of whose life it has been the sole business to perform them, is usually much greater. The rapidity with which some of the operations of those manufactures are performed, exceeds what the human hand could, by those who had never seen them, be supposed capable of acquiring.

"Secondly, the advantage which is gained by saving the time commonly lost in passing from one sort of work to another, is much greater than we should at first view be apt to imagine it. It is impossible to pass very quickly from one kind of work to another that is carried on in a different place, and with quite different tools. A country weaver, who cultivates a small farm, must lose a good deal of time in passing from his loom to the field, and from the field to his loom. When the two trades can be carried on in the same workshop, the loss of time is no doubt much less. It is even in this case, however, very considerable. A man commonly loiters a little in turning his hand from one sort of employment to another. When he first begins the new work, he is seldom very keen and hearty; his mind, as they say, does not go to it; and for some time he rather trifles than applies to good purpose. The habit of sauntering, and of indolent careless application, which is naturally, or rather necessarily, acquired by every country workman, who is obliged to change his tools every half hour, and to apply his hand in twenty different ways, almost every day of his life, renders him almost always slothful and lazy, and incapable of any vigorous application, even on the most pressing occasions. Independent, therefore, of this deficiency in point of dexterity, this cause

alone must always reduce considerably the quantity of work which he is capable of performing.

"Thirdly and lastly, every body must be sensible how much labour is facilitated and abridged by the application of proper machinery. It is unnecessary to give any example. I shall only observe, therefore, that the invention of all those machines, by which labour is so much facilitated and abridged, seems to have been originally owing to the division of labour. Men are much more likely to discover easier and readier methods of attaining any object, when the whole attention of their minds is directed towards that object, than when it is dissipated among a great variety of things. But in consequence of the division of labour, the whole of every man's attention comes naturally to be directed towards some one very simple object. It is naturally to be expected, therefore, that some one or other of those who are employed in each particular branch of labour, should soon find out easier and readier methods of performing their own particular work, wherever the nature of it admits of such improvement.

"A great part of the machines made use of in those manufactures in which labour is most subdivided, were originally the inventions of common workmen, who, being each of them employed in some very simple operation, naturally turned their thoughts towards finding out easier and readier methods of performing it. Whosoever has been much accustomed to visit such manufactures, must frequently have been shown very ingenious machines, which were the inventions of such workmen, in order to facilitate and quicken their own particular part of the work. In the first steam-engines, a boy was constantly employed to open and shut, alternately, the communication between the boiler and the cylinder, according as the piston either ascended or descended. One of those boys, who loved to play with his companions, observed that, by tying a string from the handle of the valve which opened the communication, to another part of the machine, the valve would open and

shut without his assistance, and leave him at liberty to divert himself with his play-fellows. One of the greatest improvements that has been made upon this machine, since it was first invented, was in this manner the discovery of a boy who wanted to save his own labour.

"All the improvements in machinery, however, have by no means been the inventions of those who had occasion to use the machines. Many improvements have been made by the ingenuity of the makers of the machines, when to make them became the business of a peculiar trade; and some by that of those who are called philosophers, or men of speculation, whose trade it is, not to do any thing, but to observe every thing; and who, upon that account, are often capable of combining together the powers of the most distant and dissimilar objects. In the progress of society, philosophy or speculation becomes, like every other employment, the principal or sole trade and occupation of a particular class of citizens. Like every other employment, too, it is subdivided into a great number of different branches, each of which affords occupation to a peculiar tribe or class of philosophers; and this subdivision of employment in philosophy, as well as in every other business, improves dexterity, and saves time. Each individual becomes more expert in his own peculiar branch: more work is done upon the whole, and the quantity of science is considerably increased by it.

"It is the great multiplication of the productions of all the different arts, in consequence of the division of labour, which occasions, in a well governed society, that universal opulence which extends itself to the lowest ranks of the people. Every workman has a great quantity of his own work to dispose of, beyond what he himself has occasion for; and every other workman being exactly in the same situation, he is enabled to exchange a great quantity of his own goods for a great quantity, or, what comes to the same thing, for the price of a great quantity, of theirs. He supplies them abundantly with what they have occasion

for, and they accommodate him as amply with what he has occasion for, and a general plenty diffuses itself through all the different ranks of society.

"Observe the accommodation of the most common artificer or day labourer, in a civilized and thriving country, and you will perceive the great number of people of whose industry a part, though but a small part, has been employed in procuring him this accommodation. The woollen coat, for example, which covers the day labourer, as coarse and as rough as it may appear, is the produce of the joint labour of a great multitude of workmen; the shepherd, the sorter of the wool, the wool-comber or carder, the dyer, the scribbler, the weaver, the fuller, the dresser, with many others, must all join their different arts, in order to complete even this homely production. How many merchants and carriers besides must have been employed in transporting the materials from some of those workmen to others, who often live in a very distant part of the country! How much commerce and navigation in particular, how many ship-builders, sailors, sail-makers, rope-makers, must have been employed, in order to bring together the different drugs made use of by the dyer, which often come from the remotest corners of the world! What a variety of labour, too, is necessary, in order to produce the tools of the meanest of these workmen. To say nothing of such complicated machines as the ship of the sailor, the mill of the fuller, or even the loom of the weaver, let us consider only what a variety of labour is requisite, in order to form that very simple instrument—the shears with which the shepherd clips the wool. The miner, the builder of the furnace for smelting the ore, the feller of the timber, the burner of the charcoal to be made use of in the smelting-house, the brick-maker, the brick-layer, the workmen who attend the furnace, the mill-wright, the forger, the smith, must all of them join their different arts, in order to produce them. Were we to examine, in the same manner, all the different parts of dress and household furniture, the coarse linen

shirt which he wears next his skin, the shoes which cover his feet, the bed which he lies on, and all the different parts which compose it, the kitchen grate, at which he prepares his victuals, the coals which he makes use of for that purpose, dug from the bowels of the earth, and brought to him, perhaps, by a long sea and land carriage; all the other utensils of his kitchen, all the furniture of his table, the knives and forks, the earthen or pewter plates upon which he serves up and divides his victuals, the different hands employed in preparing his bread and his beer, the glass window which lets in the heat and the light, and keeps out the wind and the rain; with all the knowledge and art requisite for preparing this beautiful and happy invention, without which these northern parts of the world would scarce have afforded a very comfortable habitation, together with the tools of all the different workmen employed in producing those different conveniences. If we examine, I say, all things, and consider what a variety of labour is employed about each of them, we shall be sensible that without the assistance and co-operation of many thousands, the very meanest person in a civilized country could not be provided, even according to what we very falsely imagine the easy and simple manner in which he is commonly accommodated. Compared, indeed, with the more extravagant luxury of the great, his accommodation must no doubt appear extremely simple and easy; and yet it may be true, perhaps, that the accommodation of European princes does not always so much exceed that of an industrious and frugal peasant, as the accommodation of the latter exceeds that of many an African king, the absolute master of the lives and liberties of ten thousand naked savages."

LXI.—*On fine and delicate Steel Works.* *By the* Editor.

The French term these fine steel works, jewellery works, or *bijouterie d'acier*; such, for instance, as dress swords, buttons, &c. &c., many of which exceed in price articles made in gold or silver, by reason of the great quantity of ingenious workmanship employed in their manufacture. And, indeed, they exhibit a great display of skill in the tasteful arrangement or combination of the various parts composing them, and such indeed as is only to be found in a few excellent workmen, and who of course obtain high prices for their productions. Still, however, the component parts of these exquisite works are, for the most part, made in the large way by persons whose business it is, and who afford them at a cheap rate, both by the division of labour, and by employing women and children to perform the chief part of the operations, in situations where iron and coal are abundant, and a living is to be obtained on moderate terms. Such parts are the diamond cut steel beads and studs in particular, and which are largely employed in the decorations of the various articles.

These steel beads and studs are formed either of well annealed sheet or hoop iron; or, which is better, of cast steel decarbonated, and which is thereby reduced to the state of the softest and purest iron, and is entirely free from the defects of the ordinary iron, such as flaws, blisters, &c., which are often found in articles made of common iron, after being case-hardened, but upon which, nevertheless, much expensive work had been bestowed. Some, indeed, of the more experienced workers in these steel works, select that kind of Swedish bar iron for this purpose which, on being broken, presents a shining crystallized fracture; but we should always prefer the decarbonated cast-steel.

If small steel beads are to be made, small holes are first pressed through the sheets of iron, by means of the tools termed beds and punches, used in fly-presses; and the beads are then afterwards pressed out, by other similar

tools, of rather larger sizes, according to the intended beads; and the punches being also formed with slender points, to enter the holes already pressed, and with shoulders, which act in the larger holes formed in the beds; and thus they press or cut out the blanks to form the beads, with holes through the centre of each. These blanks are then shaped to the spherical form, by taking each up upon a pointed steel tool, held in a file haft, and laying it upon a hard wood filing-block, with a proper file, rounding each end of it in succession. The beads are then ready to be case-hardened, previous to their being cut into facets, both of which operations will be described hereafter.

For steel studs, whether round or oval, the blanks are to be cut out of sheet iron, by means of beds and punches, in the fly press; but no holes are made through them; instead of which, a shallow slit is cut or indented in the middle of each, by a small chisel-shaped punch, with the aid of a small hammer, and which slit is made to receive the chisel-shaped point of an iron wire, and to retain it sufficiently firm, when driven in, that it may not fall out during the after progress of brazing or soldering it, and which process is effected in a nearly similar manner to that described in the article on making solid and hollow screws, namely, by enclosing a considerable number of them in a wrapper of coarse wetted paper, together with scraps of brass, and a little borax; and then enveloping the whole in a casing of plastic clay, and leaving only a small aperture in it; and, when it is become sufficiently dry and hard, exposing it to the heat of a forge fire, carefully turning it about from time to time, until the fumes of the melted zinc are seen to escape through the aperture, when it must be taken out of the fire, and be rolled about upon the ground, to diffuse the brass equally amongst the studs. When cold, it must be broke open, and the wire shanks will then be found to be firmly affixed or soldered to the backs of the studs, and ready to be screwed or riveted into the different pieces, to which they are to be finally affixed,

as the nature of the works may require. The faces of the round or oval studs are then to be rounded off with files, they being firmly held in pliers, by means of their shanks, during that operation. They will then be ready to be case-hardened, and which operation is to be performed upon them, as in the case of the beads, previous to cutting facets upon them, the shanks, however, are to be enclosed in small masses of clay, to prevent the action of the case-hardening upon them.

To case-harden the Studs or Beads.—This process is performed upon a considerable number of these at once, by putting them into shallow boxes or trays, made of sheet-iron, by turning up their sides at a right-angle all around, pinching the corners close, and securing them, by turning them back, and riveting them to the sides or ends. A layer of bone-dust, from which the volatile parts had been previously removed, by the distillers of ammonia, is then spread over the bottom of a box, then a layer of the studs or beads, upon which another layer of bone-dust is to be spread; then another of the beads or studs, and so on, until the tray is nearly filled, the uppermost layer being always composed of the bone-dust. The tray thus filled is then placed in a grate ordinarily formed of a few bars of iron, laid upon bricks, and with others in front, placed between loose bricks, which constitute the sides of the grate, and are generally built up within a recess or fire-place, furnished with a proper chimney, so as to afford a gentle draught, capable of maintaining an uniform red heat in the fuel, which is pit coal, as well as in the tray and its contents, for several hours; or until the carbon in the bone-dust has performed its office of converting the iron into steel. The tray is then to be removed from the fire, and ts contents, bone-dust and all, are to be thrown red-hot into cold water. The studs or beads will now be found in the state of hardened steel, with the exception of the wire-shanks in the studs, which are still soft iron.

The facets are cut upon the beads or studs by means of

a flat horizontal lap, as it is termed, or a wheel of pewter, rapidly turned round, and fed with flour emery and water, applied upon a few bristles tied together in the manner of a painter's brush or tool, the lap running in a shallow flat cistern, with a border around it, to prevent the emery and water from escaping; and another border around the hole in its centre, through which the spindle of the lap passes in the usual manner.

The beads are held upon pointed steel stems, driven through the holes in them, whilst cutting the facets upon them; and the studs are held by their wire shanks, in a kind of hand-vices, during that operation. The steel stems for the beads, and the hand-vices for the studs, being affixed in cylindrical wooden hafts or handles, which have several rows of flattened faces formed around them, their whole length, and which are equally divided, according to the number of facets which are to be cut upon the studs or beads. These flattened parts of the handles lodge or rest upon horizontal bars or supports, which are held by screws upon upright wings affixed in the table, around the lap, and so that their positions can be varied, according to the different inclinations to be given to the studs or beads whilst cutting the facets upon them, and are regulated, accordingly, for every different form or size of the studs or beads, as may be requisite; but, as many dozens of the same kind are always cut at one time, so these alterations do not often require to be made.

In this manner, and by regularly changing the circular and angular positions of the studs or beads, during the operation of cutting the facets upon them, and by dint of the skill acquired from being constantly in the habit of doing such work only, a great number may soon be cut.

The polishing of the studs or beads.—This is effected, in the case of the studs, by affixing a number of them upon a cement-block, by warming the cement before a fire, until it is sufficiently softened to permit the shanks of the studs to be stuck into it, and their flat backs be brought into

contact with the cement. When cold, a sheet of many of these studs, planted closely adjoining to each other, will be ready to undergo the preparing and polishing processes.

The first of the preparing processes consists in applying finely washed emery and water, by means of a large hard flat brush, made for the purpose, for a considerable length of time, or until it has, by being thus rubbed cross-wise, in many different directions, obliterated the scratches left by the emery in cutting the facets upon the studs. This is to be succeeded by a similar application of a black prepared iron stone and water, and which is to be continued long enough to completely remove the fine emery marks. The studs will now be prepared to receive the polish; this is effected by means of putty, or the combined oxides of a mixture of lead and tin, finely levigated; and it is applied, mixed either with water, or, still better, in proof spirit, upon the palms of the hands of women, for a considerable length of time; and, indeed, until the fine black polish or lustre of hardened steel is at length produced.

No effectual substitute for the soft skin which is only to be found upon the delicate hands of women, has hitherto been met with.

In *polishing beads*, a different method is pursued; the beads being strung upon a ring of wire, are, firstly, prepared by applying them against a circular brush, turned in a lathe, and supplied with oil and emery, until the marks of cutting the facets are effaced. They are next held against other circular brushes, supplied with finely washed emery and oil, until the scratches left by the coarser emery are removed; and are, lastly, polished by means of putty, applied with water, or proof spirit, upon the fingers of women.

The cement above mentioned is chiefly composed of pitch, powdered brick-dust, short cut tow, and a little bees' wax.

The Editor recollects seeing at the Soho manufactory, near Birmingham, many years since, the large flat brushes

used in removing the marks of the emery, actuated by cranks, driven by a water-wheel; and thus effecting a considerable saving in human labour.

The steel beads are usually employed in forming the shells and the pummels of steel dress sword hilts, by stringing them upon iron wires, the ends of which are secured by being riveted in holes prepared to receive them; the wires are also farther secured by being passed through small steel loops, which are screwed or riveted into holes made in the different parts of the steel works, between the ends of the wires.

The steel studs are secured, either by riveting or screwing their shanks into holes prepared to receive them; and both studs and beads are employed in the same pieces of work, according to the nature of them, and the skill and taste of the workman.

Steel buttons are formed of circular plates of decarbonated cast-steel, with iron shanks soldered upon their backs; and their faces are ornamented in a variety of ways, either by shaping them by filing, piercing, drilling, &c. &c., whilst in a soft state; as also by grinding flutings in them, by applying them to the rounded edges of pewter laps, turned in the lathe, and supplied with emery and water, after they have been case-hardened; when they may be cemented upon blocks, and be polished in either of the before mentioned modes. They may then be enriched by having studs riveted or screwed into the holes previously prepared to receive them. They may likewise be blued, by heat carefully applied; and, in fact, may be decorated in an infinity of ways, too numerous to be detailed here.

Hollow steel beads, cut into facets, are made of circular decarbonated cast steel plates, the edges of which are first raised only in a slight degree, in dies with punches made to correspond to them, in fly presses; then, in other dies and punches, which gradually bring the edges nearly upright or cylindrical; the steel being carefully annealed between each operation; and, finally, entirely cylindrical. In

this state, the flat bottom is to be removed, and a cylindrical ring will then be formed. The ends of this ring are then to be gradually contracted, by placing them between proper dies, in the fly press, and continuing to anneal them, as before mentioned; until at length the open ends will nearly close, leaving merely small holes in their centres; and their forms will become spherical, or oval, according to the shapes of the dies employed. When this process has been thus effected, they may be case-hardened, and be then cut into facets by the lap, and afterwards be polished, in either of the before mentioned ways.

The parts of a fine steel dress sword are the pummel, the gripe, the ferril, the bow or guard for the hand, the cross, and the shell. The pummel is generally formed in the shape of a vase, and is made hollow, for the sake of lightness. It ought to consist of several parts, raised out of decarbonated sheet cast steel, and which can be as readily worked into shape by the hammer as silver; and be afterwards soldered together with silver solder, which is much less visible in the joints than brass or spelter solder. The ferril can also be raised by the hammer entire out of sheet steel, or be formed into a ring, and soldered together. The gripe ought also to be made of two separate parts, raised out of sheet steel by hammering, and soldered together at their edges. The shell, which is generally of an oval figure, and rather concave in the inside, should also be made of a decarbonated cast-steel plate. As for the bow and the cross, they ought to be forged of mild cast-steel, and not of iron as usual, as that abounds with veins, and the other defects formerly mentioned, which cause blemishes in those parts of the work most exposed to the eye. The pummel, gripe, and shell are frequently decorated with open work, filled in the openings with rows of beads, strung upon wires; and are also ornamented with studs. The bow and cross, after the forging, are usually shaped by filing them; and the bow is frequently embellished with studs on both sides of it, which are secured in holes made through the bow,

by filing the shanks of the studs wedge-like, or with a flat surface upon each, tapering away to their points, and a rounded or cylindrical surface also; and the two flat surfaces being brought into contact, on placing the studs in the hole, from each side of the bow; they will, if well fitted, wedge each other tight, on being driven in by hammering them. Previous, however, to using the studs, the bow should be hardened, by heating it in bone-ashes to a proper heat, and quenching it in *boiling* water, which is quite sufficient to harden so slender a subject, and will not endanger its flawing or cracking in the process. The cross ought also to be hardened in a similar manner. Those parts which are composed of decarbonated cast-steel, must be submitted to the case-hardening process, in a somewhat similar manner to the beads and studs above mentioned. The broader, flat, concave, or convex surfaces of the shell, gripe, and pummel, as well as the smaller ones also, of all the parts, ought, after being hardened, to be ground either upon the flat faces, or the rounded edges of pewter laps, turned in the lathe, with the application of flour emery and water, at first with a coarser emery, and successively with a finer washed emery, until they are at length prepared for the polishing process with putty. The laps being mounted upon horizontal spindles, and surrounded with pieces of wooden hoops, affixed in the shallow troughs which contain the emery and water, in order to prevent the emery and water from being dispersed all around the laps.

The studs, cut into polished facets, in the manner above described, are sometimes further enriched by being mounted in beaded collets. These are small flat steel oval or circular plates, with a hole in the centre of each to receive the shank of the stud, and a recess, the size of the face of the stud; and which, when mounted in these collets, have a fine effect. The collets are made by being struck in dies, which have beaded borders cut in them, after which, they must be cut into form by beds and punches, hardened and finished by being first held against brushes, turned in the

lathe, and supplied with emery and oil; and, lastly, polished by the hand with putty.

There are also two fine steel tassels usually affixed to each dress sword hilt; these, generally, consist of beads strung upon wires, and connected with a bell-shaped polished steel top, by means of steel split rings, which rings are manufactured by persons who make it a peculiar trade.

Steel dress hat loops are formed much in the above manners, as are also watch-chains, the various parts composing which are linked together by split rings.

In order to render the larger hollow steel beads capable of being linked together with split rings, an iron wire must be inserted in each bead, in the following manner; one end of the wire being first bent double, and a small eye or loop formed in it, by bending it with pliers, whilst another wire was inserted in the doubling, it must be placed in the bead, with the loop in contact with it. The other end of the wire is then to be doubled, the doubled end inserted in the bead, and a similar loop formed in it, by driving a wire through it. The bead can now be readily linked to others. Smaller steel beads are strung, several at once, upon a looped wire, in a similar manner. Should the holes in the beads be very small, the wire may be filed away half its thickness, previous to doubling it.

We have now touched upon the chief component parts of these beautiful articles of steel jewellery; but the variety is endless; and so of course are the different methods employed in constructing them. What we have stated will be sufficient to enable our readers to comprehend the general nature of their construction; and we have suggested various improvements, which are well worthy of adoption.

We shall complete this article, by adding the French description of the manufacture of *Bijouterie d'Acier*, contained in the *Dictionnaire Technologique*, together with some remarks.

This kind of manufacture is now become of great importance to France. It was introduced about the year 1740,

and remained for a long time stationary, and its products were inferior to those of our neighbours; but for these twenty years past it has disputed the superiority with that of English manufacture.

It at one time appeared impossible for us to acquire a high degree of perfection in this branch, and several foreigners in vain endeavoured to introduce the manufacture of *bijouterie d'acier* into France, although the differences in price and finish were in our favour; but, since then, the greater command of capital has enabled us to improve our manufacture, so that it now rivals that of Italy, Spain, Prussia, Russia, and even of England itself.

Cast steel is generally employed in the finer kinds of *bijouterie d'acier*; sometimes, indeed, the best kind of iron is used, which is *cemented*, or case-hardened after the articles are formed, and they will then take a polish. When these works are thin, such as those which are intended to ornament cabinet-work, to form borders, &c., they employ cast-steel, rolled to the proper thickness, and which they cut into shape either with shears, or with beds and punches in the fly-press, and thus leave little to do, excepting the rounding off the edges with files. This is the process followed by M. Frichot, of Paris. Other manufacturers have, however, lately practised with success a peculiar process for softening the cast-steel, and then making it take, by means of dies, in the fly-press, all kinds of forms, and thus to dispense with the chasing, to abridge the labour, and lessen the cost, and they can thus afford ornaments of great perfection at but little expence. It was a M. Schey who introduced this process.

When the pieces of work are small, but of a certain breadth, and their surfaces are smooth, they cut them out of rolled iron by means of beds and punches in the fly-press; they then finish them with the file, and case-harden them. They are also formed in the same manner out of sheet-steel, but which, of course, need not to be case-hardened.

When the works are of a larger size, such as clasps for work-bags, pouches, purses, &c., sword-mountings, buckles, snuffers, &c., they are cast in soft iron, finished and cemented, or case-hardened.

The diamond-cut studs, with which the greater part of these *bijoux d'acier* are ornamented, have screwed stems, by which they can be securely affixed in screwed holes, formed in the places to be decorated with them. These are hardened, and the facets are cut upon them in the same manner as they are cut upon the precious stones, namely, by the lapidaries' mill.

All the various indispensable manipulations employed in the formation of these kinds of works, are too numerous to be described in a work of this nature; they are executed by the aid of the file, the lathe, the chisel, and the burnisher. The most important of all, however, is *the polishing;* this is the most difficult part, it requires the most care, and chiefly augments the price of those objects whose polish is the most perfect.

Before they had found out a mechanical means of polishing, with great celerity, these small pieces of steel, they commenced by preparing them upon a mill or lap; here they removed the coarser file marks; they then smoothened them with other appropriate mills, such as those formed of wood, lead, zinc, or tin, and with emery still finer and finer; and, finally, they finished them upon mills of the same materials, upon which were applied the charcoal of the fir-tree, colcothar or crocus (*rouge d'Angleterre*), or the putty of tin, and thus they at length obtained a fine polish, but the work was exceedingly tedious, and of course expensive.

The process employed in polishing needles, has also been ingeniously applied in this species of manufacture. M. M. Toussaint, the father and son, of Rancourt, in the department of Ardennes, took out a *brevet* for this invention, which is now expired. It appears that they were the first of our manufacturers who made this useful application,

and which has given a great superiority to our *bijouterie d'acier*. The following is the process:

They placed a certain quantity of these small works in a hollow cylinder, mounted upon axes, and turned either by the power of a water-wheel, a horse, or a steam-engine; they likewise enclosed with them, emery, sand, brick, glass, the oxides of iron, &c., ground in water, and reduced to the consistence of a soft paste. Each piece became thus polished on all sides, by the rotatory movement of this cylinder; but, in order to produce a fine polish, the motion should be slow, and continued without intermission for at least twenty-four hours. This first operation being terminated, they then carefully washed all the pieces clean, and turned them in another cylinder, in the dry state, for twenty-four hours longer, in contact either with crocus, putty of tin, or the black oxide of iron. They thus obtained a very brilliant polish.

The same machine might be made to turn a considerable quantity of these hollow cylinders, so that the works need never stand still.

When we would impress upon these *bijoux d'acier*, by means of dies, in the fly-press, workmanship, more or less costly, it is of great importance that the steel should be rendered as soft as possible, in order that it may receive a perfect impression. M. Jacob Perkins has invented an exceedingly ingenious process for decarbonating cast-steel, and by which it is considerably softened; and, after receiving the impression of the dies, it is finally to be case-hardened.

To effect the decarbonization, he encloses the steel in a cast-iron box, the sides of which are three quarters of an inch in thickness, and whose cover shuts as closely as possible, and is, besides, well luted. The steel lies upon a bed of iron filings, at least half an inch thick, and is besides entirely surrounded with them. This box is placed on a forge fire, and made to receive a high red heat for four hours; it is then left to cool very slowly in the fire. It

is of importance to prevent the air from entering the fire-place, in order to do which, the fire is covered with a layer of charcoal dust, six or seven inches thick, and which also extinguishes the fire.

To recarbonize the steel, M. Perkins employs animal charcoal, made by burning leather, and reducing it afterwards to powder. In cementing the steel, he places it in a box, similar to that above described, and surrounds it for the thickness of an inch with this powder. He then places the box in a furnace, similar to that employed in the fusion of brass, and gives it a light red heat; it here remains from three to five hours, according to the greater or lesser thickness of the steel; after which it is instantly quenched in water to harden it.

The best cast-steel is generally preferred for these kinds of works. L.

Remarks by the Editor.—We have seen small articles of cabinet work; and also ladies' work boxes, &c., ornamented with mountings of polished steel at their corners, their edges, and other parts of them, and which are sold as being of French manufacture. Now, as these articles are afforded at low prices, so it is evident that the French must be possessed of means for producing this polish upon steel in a quicker and less expensive manner than we are accustomed to employ. The steel mountings above alluded to, were in the form of clips for the corners, borders for the edges, plates or escutcheons, &c. &c., and were formed of thin flattened steel, possessing a beautiful polish; they were affixed by means of diamond-cut steel studs, the stems of which were pointed, for the purpose of being driven into the wood. Now, we suppose that the French workmen have availed themselves of a process which has been for some time successfully employed by the Geneva watch-makers, in finishing the flat surfaces of the steel parts constituting their works, namely, after previously smoothening them, by grinding them upon the surfaces of flat laps or mills, either formed of pewter, or of a mixture of lead

hardened by tin, with emery and water applied in the manner we have before described; they polished them upon similar laps formed of zinc, and coated with crocus, embedded into their surfaces by means of a burnisher of agate or blood-stone. We also think it likely that they may have availed themselves of the mode of polishing steel, employed by the cutlers, and particularly in finishing the rounded parts of the edges, viz. by employing wheels formed of wood, and having their cylindrical edges rounded peripheries, or flat sides covered with soft buffola or buck-skin leather glued upon them. These leather surfaces, after being turned smooth, have crocus, in the state of a fine dry powder applied to them from time to time, whilst the articles to be polished are held in contact with the rims or faces of the wheels, the latter being also caused to revolve at a moderate speed only, as too rapid revolutions would be prejudicial to their proper effect, and might soften the steel, by heating it. We have no doubt that either of these methods may be employed in giving the black lustre or polish to articles in *bijouterie d'acier*, with a beneficial result, and it highly behoves us to employ every possible means of recovering that preference, which our fine steel works have enjoyed for so many years past over those of other countries.

With regard to the mode of polishing steel, said to be employed by the needle-makers, it may possibly answer for those works where sharpness or delicacy of finish are of no importance to be preserved, as it must undoubtedly have the effect of blunting or rounding all the projecting parts; and although so many different materials are mentioned, as being to be enclosed with the articles to be polished, within the revolving cylinders, yet it appears to us that it is not intended that they should all be used at once! On the contrary, we suspect, that in the specification of the *brevet*, those different substances were enumerated, in order that any of them might be separately employed to produce the abrading effect; but that in the abridgment of it, they were all confounded together.

LXII.—*On making solid and hollow Screws, for Vices, Presses, Waggon-jacks, &c.* *By the* EDITOR.

We think it desirable, in addition to what we have given in the articles on screw-making, contained in our present number, to afford our readers a description of the singular methods employed by the standing vice-makers, and which we believe are peculiar to them, as we have not seen them practised by any other workmen.

Our knowledge is derived from witnessing the practices of a branch of the family of the *Wright's*, settled at Birmingham many years since; the original seat of their business being at Dudley, in Worcestershire, where their name has long been celebrated for the superior excellence of their articles.

The solid screws are made of the very best scrap iron, and which, of course, is of a high price, as nothing but an excellent quality of iron could possibly endure the severity it is subjected to, in bringing up the square threads of the screws in the manner we shall presently describe.

The iron cylinder for the screw being carefully forged, it is firmly held upright between the chaps of a stout screw clamp, affixed into a wooden post, secured in the earth, and the square hardened steel block, which contains the screwed hole, to form the threads of the screw, is held in a square hole, made in the central part of a stout iron lever, fifteen feet in length, and where it is firmly secured by binding-screws. The iron cylinder to form the screw is rather less in diameter than the tops of the threads of the screw, so that the threads are partly indented, and partly squeezed up by the action of the hollow screw in the block upon the iron, it having no cutting action. The lever is actuated by one or more persons at each end of it, according to the size of the screw, and who alternately advance and recede by degrees, in their progress of forming the screw; frequently also applying oil to the top of the hollow screw as they proceed, to ease the labour in some degree, which

however is very considerable, as we may well believe. In consequence of the great condensation of the iron, effected by this process, these vice and other screws acquire that hardness and great durability which they are well known to possess.

We are not acquainted with the means by which the vice-makers originally formed the hollow screws in their steel blocks; but there can now be no difficulty of effecting that operation.

The threads being thus produced around the solid screws, in order to form the hollow screws, or boxes, as they are termed, the following methods are employed:—A rod of iron is carefully forged, so as to fit and fill up the groove between the threads, but rather broader, so as to extend a little above their tops, when coiled around the screw. This coil is then enclosed within a wrought-iron cylindrical case, formed of a plate of iron turned up around the coil, till the edges of it meet. A flat web or wing of iron is then placed along the joint, and another upon the opposite side of the box, and both are then secured in their places by hoops or bands of iron driven tight over them. These webs are intended to prevent the box from turning round in the cheeks of the vice, or in the holes made to receive it, in the frames of the presses, &c., for which they are intended. And, in the case of making a vice-box, a knob of iron is also fitted into one of the ends of it, and an iron ring, larger than the box, affixed upon it. All being thus adjusted, in order to unite and combine the whole together firmly, the process of brazing or soldering is resorted to as follows:—

Slips of old brass are laid along the inside of the box, and others are also placed on its outside, and the whole is carefully enclosed within a casing of plastic clay, which is wrapped around it, avoiding however to touch the parts which are to be soldered together; a small hole is also formed through the clay, at the open end of the box; but all the other parts are accurately closed up. This encasing

of clay is then dried a little, by placing it in the vicinity of the forge fire, and, finally, it is laid in the fire itself, which is urged by blowing, until the fumes of the zinc in the melted brass are seen to escape through the hole in the clay, which is left as above mentioned, and intended for this purpose; the mass ought also to be occasionally turned whilst lying in the fire, in order to heat it uniformly. When the fumes of the zinc appear, the box is to be removed from the fire and laid upon the earth, where it is to be kept continually rolling backwards and forwards for some time, in order to diffuse the melted brass uniformly among the parts to be united by its means; it is then left to become cold, when the crust of clay is to be broken off, and the iron hoops removed. The box is now ready to have the screw fitted into it, and which is effected by placing it in a vice, and working the screw backwards and forwards in it, by means of a lever, placed in the hole formed in its head, and at the same time applying sand and water, to assist it by grinding, to make its way through the threads in the box, but which sand must afterwards be carefully washed out again.

We do not know whether or not borax is used in this soldering process; at any rate, it would conduce to its efficacy.

We may add that locksmiths use a similar process for soldering the boxes of wards in locks; sometimes, however, wrapping a sheet of thick paper around them to prevent the clay from entering them.

It is evident that a box, or hollow screw for the large screw, the construction of which forms an article in our present number, might be made in the above manner. We also think that a hollow screw might be cast around the screw, in brass or gun-metal, by surrounding it with a proper casing, and having previously coated the screw with pipe clay, to prevent the melted brass from coming into contact with it.

LXIII.—*On making Springs of hammered Iron.* *By the* EDITOR.

THE Editor was lately shown an improved lock, made by an ingenious frame-smith, from Nottingham, and in which were a number of tumblers, actuated by means of springs. On the editor objecting to the employment of so many springs, lest some of them might fail, he said that could hardly happen, for they were made of *hammered hoop-iron,* which endured much longer than hardened and tempered steel springs!

We state the fact as it occurred. It was new to us, but may be commonly employed in Nottingham, where so much excellent work is done, in making the stocking-frames, bobbin-net lace machines, &c. &c., and we have no doubt that the very slender iron rods or plates, which are employed so largely in the latter machines, are also stiffened, and greatly improved by hammer-hardening them.

The hoop-iron is now greatly used for many other purposes than that for which it was originally intended, on account of its superior quality; and it no doubt forms an excellent material for the use of the frame-smith.

We communicate this fact, in the hope of rendering it available in other branches of business, as it is only from the judicious combination of the various methods employed in different manufactures, that any real improvements can now be expected to arise.

LXIV.—*On an improved mode of making Screw Tools, for cutting hollow screws flying in the lathe.* *By the late Mr.* ANDREW FLINT, *Engineer.*

WITH FIGURES.

MR. FLINT was rewarded, many years since, by the Society for the Encouragement of Arts, Manufactures, and Commerce, for two differently constructed expanding band-

wheels or riggers, of his invention, and which well deserve to be brought into general use at the present time. He was also the patentee of a rotatory steam-engine, and indeed was an excellent mechanic.

Having found that the tools for cutting hollow screws in the lathe, or flying, as it is termed, had the ill effect of lessening the depth of the threads, owing to the improper manner in which the tools are usually made, by holding them sideways against a cutting-screw, actuated by the lathe, in the same manner as is used in forming the ends of the tools for cutting solid screws flying, and whereby their teeth are crossed, or inclined in the wrong direction for cutting hollow screws, and thus, as above mentioned, they lessened the depth of the screws cut by them. Now, in order to avoid this evil, he partly enclosed the piece of steel intended to form the screw-tool, within a thick plate of iron, bent over the back of it, and bringing its edges even with the intended edge of the screw-tool, he filed the whole into a portion of a cylinder, capable of being received within the dies of a screw-stock, and of being acted upon by them, so as to cut the teeth on the edge of the tool, in a fit and proper manner to act as a screw-tool, in cutting hollow screws in the lathe flying.

In plate V. fig. 19 represents a top view of part of such a screw-tool; and fig. 20, an end view of it. Fig. 21 shows the tool as partly surrounded by its iron casing, and as having been acted upon by the screw dies, as above mentioned; the dotted circles surrounding it may either represent the depth of the threads of the screw, or that of the hollow screw to be cut by the tool in the lathe, after being, of course, divested of its iron back, and hardened; and when it is to be held upon the lathe rest, in exactly a similar position with respect to the hollow cylinder to that here shown.

It is evident that such a screw-tool will turn or cut a hollow screw in the lathe, as deep as the threads of the original screw which formed the dies. But should its edge

not be thought sharp enough, that may be remedied by hollowing it a little upon its face, in the well known manner of making hook-tools, &c. It is however evident, that its edge forms a radius line with the centre of the hollow cylinder in which the screw is to be cut, and which is generally thought to be the best position for cutting well, and as is indeed the case with the improved screw-taps made by Mr. James Jones, and as described in the present number.

We may also remark, that when the ordinary tools for cutting hollow screws in the lathe flying, have been thinned, by grinding or whetting them, they will cut deeper threads than when of their original thickness; but then they lose their property of leading greatly, and which valuable property can indeed only be possessed fully by the above improved tools.

LXV.—*On a domestic medicated Steam Bath, which can be fitted up, extemporaneously, with materials to be found in almost every house. By* John Isaac Hawkins, *Engineer.*

Hampstead Road,
April 10, 1830.

DEAR SIR,

From the numerous well authenticated accounts which have reached me from time to time, during several years past, of the very great efficacy of Mr. C. Whitlaw's patent medicated vapour bath, and from my own serious consideration of the subject, I have given full credence to the importance of administering the medicinal virtues of herbs to the human body by means of steam; and I long since intended to avail myself of the advantage of using steam as a vehicle for medicine, in case I should ever be afflicted with any disease, for which that might be a desirable remedy.

But it has so happened, that when I have been taken ill, I have sometimes not thought of the steam bath; and

at other times, when I have thought of it, the trouble and expense of procuring it, have induced me to postpone my intention, and once more try to obtain relief by loading and offending the stomach with nauseous compositions from the apothecary. I say trouble and expense, because living as I do four or five miles from any of Mr. Whitlaw's steam bath stations, I must either go to one of them, and return in a coach, at a cost of eight or ten shillings, and pay seven shillings for the bath, and a pot of coffee, with its accompaniments, and, of course, a trifle to the waiter; or, at a still greater expense, I must send to Mr. Whitlaw for a bath, and a person well skilled in the management of it, and thus have all the paraphernalia of a regular steam boiler, with its furnace, safety-valve, vacuum-valve, pipes, cocks, &c., and also a tent, brought into my bed-room, at a time perhaps when a state of quiet might be much more agreeable, and at all events, some hours after the bath would be judged necessary.

Thus, then, I must pay as much for one dose, as for a week or two of a regular supply of potions, powders, and pills from the apothecary; of whom, I never yet heard it asserted, that he delighted in selling articles remarkable for their cheapness!

In mentioning trouble and expense, however, I am only stating what were my considerations previously to having experienced the benefits of the medicated steam bath; but having now had that experience, I hold the trouble and expense as of no account, compared with the immense advantages attending its application.

These advantages may be in some degree appreciated, when the mode of operation is duly considered, in relation to the practice of forcing medicine into the stomach, there to await the slow process of separation and digestion before it can come into action. The stomach has but a few inches of internal surface, upon which the medicine can at first act, and a considerable portion of time must elapse before the peculiar virtues of the medicine can be separated from

the chaotic mass with which it is there commixed, and before its healing qualities can be conveyed into the circulation, and until that takes place, little or no benefit is to be derived from it.

On the other hand, the aromatic parts of the herb being carried, in an indefinitely divided state, to every minute pore of the whole surface of the skin, and at the same moment into the inmost recesses of the lungs, as well as a portion also finding its way into the stomach, by mixing with the saliva; the whole body may be better impregnated with the medicine in a few minutes, than by the circuitous rout of the stomach alone, could be performed in many hours, or even days.

But to leave opinion and reasoning, and come to plain fact, I have now to state, that in the last winter, my eyes became so exceedingly inflamed, through using them too much in reading and writing, and from having taken a severe cold, that I concluded I must banish all my books and papers, and submit to some weeks of medical treatment.

I went to bed early in the evening, and there set about to consider what course to pursue. Mr. Whitlaw's medicated steam bath occurred to my mind; I felt a strong desire to experience its effects, and had a perfect confidence of relief in my case, but how to obtain it was the question? It was clearly too late that evening, and probably it would be the afternoon of the next day before it could be sent for and arrive, and I was too unwell to go myself to Mr. Whitlaw's. The pain of my eyes made me forebode a restless night, and I therefore wished to have the bath that night. A thought luckily struck me, how I might have it prepared immediately.

I ordered the servant to go into the kitchen, and fetch two large covered saucepans, two small tea trays, a high stool, a low stool, a two-leaved clothes-horse, and a large wooden spoon. These articles were soon forthcoming, except the spoon, instead of which a pudding beater was brought. I procured also a pair of bed sheets.

The two saucepans were half filled with water, and put upon a brisk fire in the bed-room.

Upon refering to Culpepper's Herbal, for the herbs most adapted to cure diseases of the eyes, I selected from his list eye-bright, balm, pennyroyal, rosemary, and savory, all which I happened to have in the house, and I put about a pennyworth of each into the two saucepans.

While the water was heating, I placed the clothes-horse upright on the floor, with the two leaves opened about a yard wide, in front; one of the sheets was then hung over the two leaves, and reached down to the floor. The other sheet was put on the top, and hung down to the floor before the opening, and thus formed a kind of door to this little triangular tent, thus simply constructed. The high stool was placed at the back, and the low one at the front part within the tent, and one of the trays on the floor, between the two stools; the other tray was laid on the floor, outside the tent-door.

So soon as the water, or rather herb-tea, in the saucepans boiled, I stripped and entered the tent, sitting on the high stool, and placing my feet upon the lower one. One of the saucepans was then put into the tent, upon the tray between the stools, and the door was closed to keep out the air.

I lifted the cover of the saucepan, gradually, to let the steam arise, just as fast as was agreeable. In a few seconds I could bear the cover quite off, and was comfortably enveloped in the vapour, which soon condensed all over the surface of my body, producing a very pleasant effect. But the sensation of the aroma on the lungs was peculiarly comfortable.

In about a minute or two the steam ceased to arise as copiously as I wished, and I had recourse to the stirrer, with which I agitated the decoction, and again the tent was filled with vapour. I continued thus stirring for two or three minutes, and then placed the saucepan upon the tray outside the tent; instantly on my doing this, my

assistant put the other saucepan into the tent, in a boiling state; the door of the tent in both cases being lifted no higher than was barely necessary to pass the saucepans out and in. The exchange occupied but a few seconds of time, and I did not feel the cold air enter the tent.

From the second saucepan, a copious supply of vapour was obtained in the same manner for about five minutes more, at the end of which time the first saucepan, which had been put on the fire again, was once more boiling hot, and then a second exchange took place, and afterwards a third; each saucepan having thus been made to boil twice, had afforded an abundance of medicated steam for about twenty minutes.

After well wiping myself, I went to bed again, where my sensations were very pleasant. The inflammation of the eyes was much reduced; but an eruption on the face, hands, &c., which had begun to appear on the morning of that day, was increased tenfold in the bath, both in the number of pustules, as well as in their size; the pain of the eruption, however, was very much lessened, and I enjoyed an exceedingly comfortable night, instead of the miserable one which I had anticipated.

The next night I took a second bath; the pustules of the eruption were, in this bath, reduced to half their previous size, and the inflammation of the eyes was nearly removed.

On the third night I took a third bath, by which the inflammation of the eyes was entirely removed, and the eruption completely levelled; leaving only liver-coloured spots where the eruption had been, and which spots all disappeared in two or three days. I went out of the bath and into bed, as in the former cases, where all my sensations were indescribably delightful, and I pronounced myself quite well; and this great effect was produced in forty-eight hours, by the use of three baths only.

On the fourth day I went into the city upon business, and felt remarkably vigorous, indeed much more so than I had experienced for some months previously; and on the fifth

day I had the rashness to read and write for ten hours, yet without inconvenience. I had scarcely been able to use my eyes in that way, for three hours in any day, for a considerable time before this.

Upon the eighth day, I felt that the whole of the humours which had caused the disease, had not been expelled, although I had taken the precaution of keeping the body well open by proper medicines. I therefore on that night took a fourth bath, with a most beneficial effect; and on the ninth night a fifth bath, which restored me to complete health, and to a degree of strength and activity far greater than I had experienced for two or three years before.

Having lately resided much on the continent, where bathing is more used than in England, I frequently took a warm water bath, but always felt a degree of languor for some hours afterwards. On the contrary, in every case of my five medicated steam baths, I have experienced an increase of vigour, not merely transient but durable. I am convinced that the warm water bath is in its nature enervating, while the steam bath, on the contrary, is in its nature invigorating.

In my great anxiety to make this statement public, and to show that the medicated steam bath is now in every person's power to use at all times, I am not in the least degree disposed to take away either from the merit or the business of Mr. Whitlaw; for I think he is deserving of the utmost encouragement for his indefatigable perseverance in the introduction of this most valuable mode of administering medicines; and I should sincerely rejoice in seeing him so well encouraged, as to enable him to establish and support one of his patent medicated steam baths in every parish; for I am sure that the health of the public would be essentially benefitted by the general use of this most powerful, speedy, and safe remedy.

I am quite certain that I shall receive the thanks of numerous persons, who, like me, have a knack at helping themselves, and feel pleasure in it, rather than in depending

upon others, and who will fit up their little tents in their bed-rooms, and send into their kitchens for saucepans, &c. But I know human nature too well, to expect that the multitude, either of rich or poor, will take the steam bath, except every thing be prepared to their hands; I therefore think that this publication will rather do Mr. Whitlaw good than harm, in a pecuniary point of view; for every person that takes a steam bath in my way, will be eager to recommend the same to his friends; among whom, many helpless mortals, who spend half their time in waiting to be waited upon, will either go or send to Mr. Whitlaw, in preference to taking, what they imagine to be trouble, in helping themselves.

The clothes-horse, when folded together, measured about four and a half feet high, and two and a half feet wide. It need not be larger, except for very tall persons.

The sitting stool was eighteen inches high, I did not wish it more or less.

The footstool, nine inches high, kept the feet above the level of the saucepan-brim, and, consequently, the steam was able to spread under them. It would be better to have a perforated footstool, and let it stand partly over the saucepan.

The saucepans measured six quarts each, and were about half full. They were of a very convenient size; for, if they had been larger, the exchange could not have been made so quickly, and if much smaller, they would scarcely have afforded sufficient steam.

In addition to the five baths above mentioned, I steamed my eyes three or four times a day, for the first three days, with the vapour of eye-bright decoction, of which I put about a pint in a boiling state into a small vessel, and held the eyes over the steam; and I chose this herb, in consequence of the very high encomiums passed on it by Culpepper, who says, in his Herbal, "if it were but as much used, as it is neglected, it would half spoil the spectacle-makers' trade. I used the other herbs also, because they

are recommended for inflammation of the eyes, and I knew that they would not injure the lungs.

Although the steam bath is so highly beneficial, it must not be used at random; nor without due preparation, by evacuating the body, both by stool and urine; for which purpose the usual medicines ought to be taken for a day or two previous to using the bath. For should the steam be used when the bowels or bladder are full, the impurities, not finding vent into those natural receptacles, might be forced into the circulation, and thus do irreparable mischief.

The herbs, too, must be selected with a thorough knowledge of their respective qualities; medicines that would agree well with the stomach, might be highly prejudicial to the lungs. Any medicine, for instance, that by the heat of steam gives out a poisonous vapour, must be highly injurious when inhaled by the lungs, although possibly harmless when taken into the stomach, as the vapour might there be absorbed and neutralized by the aliments, or by the gastric juice.

I should, as a general rule, say, that except in cases where great medical skill and experience might prescribe poisonous vegetables, the medicines ought to be taken from the common pot and tea herbs, such as thyme, sage, marjoram, hyssop, horehound, ground ivy, and the five before mentioned ones, all of which tend to allay inflammation. And I would recommend the medicated steam bath in all cases of an inflammatory nature, or bordering upon inflammation, whether local or general. I am quite satisfied that a common recent catarrh would yield to one or two baths, except when accompanied with some other disorder.

Perhaps, in making these remarks medical gentlemen may deem me an intruder on their province; to whom I would observe, that it is not a department quite new to me; since, when I was a young man, now thirty years ago, I studied the healing art in that excellent school of

medicine the university of Pennsylvania; and might have taken a diploma, authorising me to attach M.D. to my name, had not my passion for mechanics led me from that pursuit to revel among machinery; and particularly to direct and apply the powers of that master-piece of human ingenuity the steam-engine; the invention of which, highly as I prize it, from more than a quarter of a century's intimate acquaintance with it, I place far below the invention of the steam-bath, in real value to mankind; and consider the name of Whitlaw as deserving to take precedence even over those of Watt, Trevethick, and Perkins; for although he is not the original inventor of the steam-bath, any more than they were of the steam-engine; yet he has the high merit of being the introducer of the medicated vapour bath, in a convenient form, into civilized society.

In his work, entitled "Whitlaw's New Medical Discoveries," vol. I., London, 1829, pp. 86 and 87, he acknowledges having both seen and felt the medicated steam bath in operation among the Indians of North America; and he thus describes the mode adopted by those simple children of Nature. "In the various species of inflammation, the Indians always resort to the vapour bath, constructed upon a principle peculiar to themselves; it is after the following manner. A few heated stones, in the first instance, are heaped together, round which something similar to a soldier's tent is erected. The person or persons to receive the bath are seated round the stones, upon which are thrown herbs, and water is sprinkled with the hand. I tried one of them, and must say that the heat and vapour arising from the stones were suffocating in the extreme. The discipline was severe, but the beneficial effects I derived from excessive perspiration, when afflicted with an habitual tendency to a flow of blood to the head, proved the propriety of inhaling gases by the lungs, in order to relieve and effectually cure disorders in general."

I have extended this paper to a greater length than I

had originally intended; but the importance of the subject will, I hope, plead my excuse.

I remain, dear Sir,

Yours, obediently,

To T. GILL, *Esq.* JOHN ISAAC HAWKINS.

P.S. After writing the above, the situation of persons having no attendants to wait upon them occurred to my mind, and I wished to put it in their power also to take this bath.

As each of the saucepans had about three quarts of water in them, and were heated twice, so the steam for one bath was obtained from three gallons of water; it was therefore evident, that one vessel holding three gallons of water would produce the requisite quantity of vapour, from being heated only once; and the trouble of exchanging saucepans might then be dispensed with, and thus the bath be taken by a single person, without any attendance.

Not having a three gallon vessel at hand, to put the scheme to the test of experience, I took a two gallon boiler, and when that was in a boiling state, I covered it, and put it into the tent. I then immediately stripped and entered it. After the cover was removed, the steam arose abundantly for about five minutes, without stirring the liquor; and afterwards for ten minutes more with stirring it. Then I put my hand out of the tent, and took the heater of an Italian iron out of the fire in a red hot state, and quenched it in the decoction; and which, with the aid of stirring, afforded vapour for three minutes longer. A second red hot iron prolonged the time for another period of three minutes, and thus an excellent bath of twenty-one minutes' continuance was obtained from two gallons of the decoction, without exchange of vessels, or without any attendance.

A three gallon vessel is, however, to be preferred, as the risk and trouble of taking the red hot irons into the tent would then be avoided, as also the evolution of a small

portion of hydrogen gas, arising from the decomposition of the water in contact with the red hot iron.

After removing the cover, I placed a grating of wood upon the boiler, consisting of two pieces, each about an inch square, and five or six inches longer than the diameter of the boiler; these were held together at two inches distance from each other, by two other shorter pieces, nailed across them. Whilst the steam was strong, I put my feet alternately on the grating and on the footstool; but after a little stirring, the feet could remain on the grating, the temperature being then lowered.

LXVI.—*On the great utility of the Camera Lucida to Travellers. By Captain* Basil Hall, *R.N.*

We have lately seen forty etchings by Lizars, from sketches made by Captain Hall, with the camera lucida, in North America, during the years 1827 and 1828, and which afford a convincing proof of the extraordinary powers of this exceedingly portable instrument.

We believe that we cannot give our readers a better idea of the estimation it was held in by Captain Hall, than by transcribing his own words.

"The following etchings have been selected from a series of sketches made with the camera lucida, in America, during the years 1827 and 1828, and the utmost pains have been taken to adhere to the original drawings. No reduction, enlargement, or embellishment, has been allowed in any instance; but the very lines traced on the spot, have been transferred to the plates, in order to preserve, as far as possible, the character of truth which the mechanical accuracy of the camera lucida communicates to its work, even in hands but little familiar with the management of the pencil.

"This valuable instrument ought to be more generally used by travellers than it now is; for it enables a person of ordinary diligence to make correct outlines of many foreign

scenes to which he might not have leisure, or adequate skill, to do justice in the common way.

" It should be recollected, that in most cases, it is not striking or beautiful views that we require, but merely correct representations as far as form is concerned, of those familiar objects which strike the eye of a traveller every where in his path as characteristic of the country he is visiting.

" If his sketches be further relieved by lights and shadows, another step is made towards the attainment of this purpose; for even a very few such touches, if strictly true to nature, often serve to place new scenes more distinctly before us, than the most elaborate or the most graphic verbal description can ever hope to accomplish.

" This instrument brings both these requisites within our reach; for although it be generally used for outlines alone, there seems no reason why the shading should not be as correctly delineated as the bounding lines of the trees, houses, water, or even the living figures, which are brought within the field of view.

" Artists accustomed to draw in the common way, are sometimes teased with the rigid accuracy, and the confined limits, to which the camera lucida subjects them; while persons altogether ignorant of the subject, are disappointed to find, that for the first day or two, they advance but little. Both parties complain, and not without some reason, that they cannot see the pencil distinctly, or that they lose sight of the object they are drawing just when they wish most to see it; and also, that the apparent motion in the image, caused by the slightest change of motion in the eye, perpetually throws them out. But they may rest assured, that a little perseverance, will put all these difficulties to flight; after which, the wonderful economy of time and trouble will far more than overpay the short labour of instruction.

" It adds greatly to the advantageous and agreeable use of the camera lucida, to have a portable table as part of

the apparatus. For this purpose, Mr. Dollond, instrument maker, in St. Paul's Church-yard, London, has recently devised a small brass frame, which folds up when not in use, so compactly, as to stow away within the legs of a stand, not larger than a walking-stick. This, together with a camp-stool, of the same slight description, renders the draughtsman quite independent of further assistance, especially if his instrument be furnished with the double movements, and other contrivances, recently adopted by Mr. Dollond. With his sketch-book in one pocket, the camera lucida in the other, and the sticks above mentioned in his hand, the amateur may rove where he pleases, possessed of a magical secret, for recording the features of Nature with ease and fidelity, however complex they may be; while he is happily exempted from the triple misery of perspective, proportion, and form, all responsibility respecting these being thus taken off his hands.

"In short, if Dr. Wollaston, by this invention, have not actually discovered "a royal road to drawing," he has at least succeeded in Macadamising the way already known."

Edinburgh, July 2, 1829.

LXVII.—*On the Graphic Telescope, invented by Mr.* Cornelius Varley; *Mechanical Draughtsman, Clarendon-square, Somers-town.*

It would not be fair to omit the present opportunity of justly praising the camera lucida, in also putting in a claim in favour of this other excellent drawing-instrument; but which is not, however, by any means so well known as it deserves to be. It may, perhaps, afford our readers some idea of its wonderful powers in assisting correct delineation, when we inform them that it was employed by Mr. Horner in tracing his extraordinary and successful panorama of London, and many miles around, from the lofty situation now occupied by the cross above the dome of St. Paul's;

and which panorama is now exhibiting in the Colosseum in the Regent's Park.

Mr. Varley had furnished Mr. Horner with several of his graphic telescopes; but the fact of one of them at least being actually employed in delineating the panorama of London, was evinced by an accident which befel it; when, in consequence of a high wind, the cabin erected by Mr. Horner was so greatly shook, that the graphic telescope fell out of it; and was so much injured, that it was sent to Mr. Dollond's to be repaired.

It is well known that the camera lucida acts upon the refracting principle; the graphic telescope, on the contrary, acts by reflection; and, on making comparative trials with the two instruments some years since, the Editor thought the preference was due to the graphic telescope, in point of facility in using it. However, they are both highly valuable instruments; and the graphic telescope possesses, besides, the property of being capable of being used as an ordinary telescope.

Mr. Varley, following the example of Dr. Wollaston, secured the benefits to be derived from the sale of his graphic telescope, by patenting it; but both the patents are now expired, and the two instruments of course can be made by every optician possessed of the requisite skill. And, indeed, since the expiration of his patent, Mr. Varley has exerted himself in extending the means of manufacturing his graphic telescopes with greater dispatch, in order to continue to derive that benefit from his invention which he is so well entitled to.

We hope soon to see both these valuable instruments more frequently employed than they have hitherto been.

LXVIII.—*On a Portable Filtre. By Mr.* J. I. HAWKINS, *Engineer.*

Mr. HAWKINS has, for many years, been accustomed to the manufacture of filtres, both for purifying water, and the

syrup in sugar refining, by that superior mode adopted by the late Mr. Howard. His water-filtres have long been known, and highly esteemed; they consist of a layer of vegetable charcoal, in powder, of a proper degree of coarseness, namely, about that of the grains of fine gunpowder, interspersed between two earthen plates, pierced full of holes, by means of needles, before the plates are baked, and which plates are also mounted in vessels formed of earthenware, so that they cannot be acted upon by the water; and the Editor can testify to their great utility from his own experience. And, indeed, there can be no better medium than charcoal employed for this purpose, both on account of its great porosity, and its indestructibility by the passage of the water through it. These filtering vessels, however, are not portable ones.

Mr. Hawkins's portable filtre consists of a small conical bag, made of silk velvet, with the pile inwards, and of another bag fitted within it, formed of silk sarcenet; the inside of the velvet being strewed all over with freshly burnt animal charcoal (ivory black), both bags being also secured to rings, formed of wire, made from German silver *(kupfer-nickel)*, which is not liable to oxidation by the action of the water upon it. These conical silk bags are supported within another flat ring (likewise made of German silver), and which has a forked metal branch riveted to its rim, and capable of being turned half-way round, so as either to lie upon and within the compass of the ring, or to be turned into the contrary direction, and thus form a support or handle to the ring. The whole of this apparatus is contained in a round flat varnished paper snuff-box, only four inches in diameter, and an inch in depth, so as at all times to be conveniently carried in the pocket.

With this exceedingly portable apparatus, Mr. Hawkins now always has it in his power to filtre any water he may require, either for drinking at his meals, for making tea, &c. &c.; and its action is sufficiently rapid and effectual; for the power of animal charcoal is well known greatly to

exceed that of vegetable charcoal, in its anti-septic quality.

In his former experiments on filtering, Mr. Hawkins tried various animal and vegetable substances to form strainers or supports for his charcoal; horse-hair and wool were very soon decomposed by the action of the water; so also were linen, cotton, and other vegetable substances; so that he was obliged to discontinue their use. Silk alone he found to resist the action of water for nine months together; and, accordingly, he has now chosen this material to construct his new pocket filtres. He can carry them even whilst wet in his box, without any inconvenience whatever.

We may here remark, that Mr. George Field, now of Isleworth, found a silk Bandana handkerchief to be the best material to form the strainer of his excellent physeter, or filtre of; and for which invention, and others, employed by him in his business of a superfine colour manufacturer, he was many years since rewarded by the Society of Arts, for the benefit of the public; notwithstanding which, it has since been repeatedly attempted to monopolize it by patents; and indeed very recently a patent has been obtained for this old invention; such is the general ignorance respecting the law of patents.

LXIX.—*Recollections of his father, the late Mr.* THOMAS GILL. *By the* EDITOR.

(*Concluded from Vol. V. page 366.*)

HOWEVER severe were the trials Mr. Gill subjected *his celebrated warranted sword-blades* to, such as bending them, striking them flatways on a cast-iron plate, and edgeways upon a cylinder of iron, and as described in our former articles; yet, in consequence of the suggestion of a military gentleman, he afterwards proved them in a still more severe manner. This gentleman, after witnessing the above mentioned trials, observed, that in the actual ca-

ployment of swords, besides being used in attacking an enemy, they likewise served to defend the soldier himself, who warded off the strokes of his adversary by holding his sword blade in a perpendicular posture, either behind him, or one side or the other, or in front, as the occasion might require; and that in this case, it was liable to be broken by the strokes of his adversary's sword, and therefore he wished the blades of the swords he ordered, to be also tested in a similar manner. Accordingly Mr. Gill, whose object it always was, to expose his sword-blades to severer trials in his own hands, than they were ever likely to be exposed to in actual use, immediately constructed an apparatus to hold the sword-blades in the perpendicular position, and then caused them to be struck across by the edge of another very heavy sword-blade, applied with the utmost strength of a workman, so as to endeavour to break them. In this way, finding that several sword-blades, which had endured all his former proofs, failed in this still more severe one, he, without hesitation, immediately adopted it, and subsequently exposed all his sword-blades to that additional trial also.

Mr. Gill was the perfecter of those very useful fire-arms, the *spring-bayonet pistols, or blunderbusses.* Before he improved their construction, the bayonet was actuated, on being let loose from its first detent, by means of a spring affixed to its shoulder, which re-acted against the barrel of the pistol; but in case the bayonet struck against any obstacle in its way to attain its proper position for use, or to extend itself in a straight line with the barrel, it would hang down powerless, in a perpendicular posture, and could only be carried up to its destined situation, and secured by the second detent, by the hand of the party holding the weapon; but in this case, the only chance of the bayonet being useful, was perhaps lost, owing to the delay occasioned in its movement.

Instead of the spring above mentioned, Mr. Gill enclosed a stout watch-spring, in a neat cylindrical box,

affixed in the joint upon which the bayonet moved, and which spring was properly wound up, so as to possess strength enough to carry the bayonet up to its resting place, and detent it securely, even though it should be held back during the whole of its progress from its first position. The spring-bayonet pistol, or blunderbuss, now became a really serviceable weapon, either for the defence of a house, or of a traveller in a chaise, &c.; the firing off its charge being always left to the last extremity, and in case the bayonet failed to repel the attack.

We may also mention a great improvement which Mr. Gill effected in that useful instrument, the snuffers. A Mr. Pinchbeck had, many years since, contrived a pair of snuffers, in which the snuff of a candle could be extinguished, after being cut off, by being pressed between the snuffer plate, or cutter, and another plate held in the box of the snuffers, instead of continuing on fire after being loosely lodged in the box as usual, and thus producing the usual offensive well-known smell occasioned thereby. This second plate was then to be raised by the application of the left hand, the snuff was to be pushed into the box by the action of the cutter-plate moved by the right hand, and the plate was then to be lowered by the left hand, in order to retain the snuff in the box. Now Mr. Gill contrived to render this second plate capable of being actuated solely by the hand which held the snuffers; and, after snuffing the candle, and pressing the snuff between the cutter-plate, and the second plate to extinguish it, and then again opening the snuffers a little wider than at the first operation; upon closing them, the second plate rose of itself, and again descended during the action of shutting the snuffers, and thus the complex movements required in using Mr. Pinchbeck's snuffers, were entirely dispensed with, and, accordingly, Mr. Gill's patent self-acting and extinguishing snuffers, immediately became a favourite article of sale, and have now continued to enjoy the preference shown to them by the public for upwards of forty years!

Mr. Gill was much attached to riding on horseback, from the exercise which it afforded him, and the benefit he consequently derived in the improvement of his health, and he therefore always rode horses of considerable value. It so happened, however, that a favourite horse had the misfortune to have a tooth, which grew to such an extraordinary length, as totally to prevent it from chewing its food. In this predicament, it occurred to Mr. Gill, to remove this tooth, by excision, or cutting it off, a practice now beginning to be introduced amongst us as a novelty. In order to this, he caused a strong pair of cutting-nippers to be made, with handles each a yard long, and their jaws only an inch and a half, and the cutters also placed on the side, not at one end of the nippers. With this powerful instrument, he completely succeeded in cutting off the projecting part of the tooth, although it was situated in a part of the horse's mouth which rendered it difficult to reach it, and the animal was thus again enabled to chew his food readily.

Mr. Gill also considerably improved the manufacture of twisted gun-barrels. Instead of forming the ribands (as they are termed in the trade), of which they are composed, with square edges, as usual, he sloped one of them off, or bevelled it, and the consequence of that change in its form was, that in the act of being wound upon the solid cylinder, to form the barrel, it assumed a new shape, and fitted so accurately to the other sides of the coils, that instead of leaving a gap between them, as in the common way, they were applied so closely together as not to leave room enough even for spelter-solder to insinuate itself between them, in an experiment which was purposely made to determine the exact position in which they lay when thus coiled. Upon sawing the barrel in two lengthways, the coils were found lying in close juxta-position, and most admirably fitted for welding together. The ribands were formed of different thicknesses in grooved rollers, actuated by machinery, and were then welded together at their

ends, the thickest being intended to form the breech, and the thinner ones the other parts of the barrel. These were uniformly heated red-hot in a reverberatory furnace, and were then wrapped or coiled around an iron cylinder, which was also guided uniformly along, by being connected with a long screw, the flat threads of which were of an equal thickness with that of the ribands; and they were pressed into contact with the iron cylinder, by being passed underneath a cylindrical pressing roller. These barrels, thus coiled, were then ready to be welded as usual.

In order to render these twisted gun-barrels still stronger, he coiled another layer of ribands over the first layer, but in an opposite direction to them, and thus formed, as it were, a reticulated combination, the one layer crossing the other, and both thus effectually resisting the power of the gunpowder to burst them asunder, after being properly welded together.

LXX.—*On the Microscope. By the* Editor.

(*Continued from page* 210.)

The late Dr. Wollaston's Microscopic Doublet.—We are now able to congratulate our microscopic readers on this very superior instrument being afforded at only one-fourth of the price hitherto charged for it.

Mr. C. Gould, at Mr. J. Cary's, the celebrated optician in the Strand, has just put into our hands one of these instruments, in order that we might be able to prove its powers with the most difficult test objects. And, accordingly, we have placed under it the long-notched, or cleft scales of the *brassica* butterfly, and also those of the *podura*, with a doublet of about the twentieth of an inch compound focus, and another of about the thirtieth of an inch focus, and never have we viewed those objects with greater distinctness, or under more favourable circumstances!

The facility of using this microscope, is likewise a considerable recommendation in its favour; as the proper

management of the light, an object of the greatest importance, is now readily acquired; and its nice adjustment for the focal distance is effected by means of a finely threaded screw.

We have no doubt that this superior instrument will now become a favorite with the microscopic part of the public, and greatly contribute in extending the use of that invaluable aid to our limited vision, the microscope.

This instrument possesses the power of exhibiting the minute bodies *with extreme distinctness;* and which, as Dr. Wollaston justly observes, in his description of it in the Philosophical Transactions*, "is absolutely necessary for *an original examination of unknown objects.*"

Its great portability is also no small recommendation in its favour, as it is inclosed in a neat mahogany box, which is only two inches in depth, two and a half inches wide, and three and a half inches long; and can therefore be conveniently carried in the pocket.

Mr. C. Gould's mode of mounting microscopic objects, to be viewed under highly magnifying powers.—Mr. Gould furnished us with some of the scales or feathers from the wing of a butterfly, properly mounted for viewing under a power of the twentieth of an inch focus, or even higher; and which, as it is a very convenient method, and readily practised, we think deserving of being made known.

The feathers being placed in the centre of a slip of crown glass, one and a half inches long, and half an inch wide, are covered with a slip of very thin talc or mica, which is cemented at each end upon the glass slip, by means of a solution of gum-arabic in water, to which a little pure acetic acid is added; and the talc is itself covered and defended from injury, excepting in that part of it which is necessarily left open in order to view the objects, by being covered with a piece of thin paper, the size of the glass slip, and having a circular aperture in its centre, a quarter

* See also vol. V. page 321, of this work, where a description of the instrument will be found.

of an inch in diameter, and which paper is also cemented by gum-water.

There is quite sufficient space upon this covering paper to receive in writing the name of the object inclosed, together with a number or other mark of reference to it, and its thickness preserves the talc from being injured, although it is not so great as to present any impediment to the employment of highly magnifying powers in viewing the objects.

Mr. William Tully's mode of mounting transparent objects for the microscope.—We have seen several pairs of glass sliders, fitted up by Mr. Tulley in a very neat manner; and indeed, at a first glance, we thought they had delicately cut papers placed between them, with circular rings or borders, to keep the various minute objects distinct. However, Mr. Tulley has since informed us, that these rings were formed upon the surface of the glass itself, by holding it steadily against the end of a short piece of brass tube, fitted into a chuck in his lathe, and supplied with finely washed emery and water; and thus he was enabled to remove the polish from the surface of the glass, in a ringlike shape, and by successively shifting the slip, to form several such rings adjoining ro each other.

Mr. William Tulley's glass micrometers:—He has constructed a dividing engine, with a diamond point, and with it has formed micrometers, containing *twelve thousand lines in a single inch!* These lines are also crossed by others, thus forming squares; still, however, the lines are necessarily so fine, as to be nearly invisible to the naked eye; and, therefore, in order to find them more readily, Mr. Tulley surrounds them with an opaque circular ring, produced in the manner above described.

On superior wood cuttings for microscopic objects:—A scientific friend has lately afforded the Editor a hint, which, if properly acted upon, promises to afford wood cuttings of *even superior thinness* to those formerly produced by the celebrated Custance, and who has hitherto had no suc-

cessor of equal skill; in consequence of which, his cuttings now sell at double their original prices. A view of a good collection of such cuttings, is indeed one of the highest treats which the microscope affords us, in the astonishing display of the beautiful and minute reticulations produced by a transverse section through the sap and other vessels of plants; but which can only be seen in perfection in sections of extreme tenuity.

Caution against using slips of Bohemian plate glass, to contain transparent objects for the microscope:—Our worthy friend and correspondent, Mr. T. Carpenter, has found to his great dissatisfaction, that objects mounted between slips of the Bohemian plate glass, in the manner he has practised for several years, have become greatly injured by being surrounded by minute drops of water, evidently produced from the decomposition of the glass. In consequence, he has been obliged to employ crown glass, which, although now not so flat, and therefore not to be compared with the Bohemian plate glass in that respect, yet answers tolerably well, and is free from that inconvenience of the drops of water forming themselves between the glass slips. We know not whether the English plate glass is liable to a similar defect; but there can be no difficulty in having crown glass ground flat and polished; and especially where the very thin pieces can be employed in such small portions as we have indicated in vol. III., page 195.

On Mr. Holland's mode of mounting transparent objects for the microscope, preserved in spirits of wine.—In our third volume, page 196, we mentioned that the above gentleman had kindly presented the Editor with a beautiful preparation of the intestines of a bee, secured and cemented between a slip of glass and another of talc, by means of white lead ground in oil, and surrounded with proof spirit. It is now a year and a half since Mr. Holland prepared this object, and although a small portion of the spirit has exhaled in this long period, yet the object still retains enough of its primitive beauty to justify us in

recommending this superior manner of preparing microscopic objects. It is well known that in the usual way of mounting them, the minute blood vessels shrink up in drying, and thus lose all their distinctness; whereas, in the parts of this object which are still immersed in the spirit, their original wonderful and delicate structure is still displayed; and so also are their different colours, as red, purple, yellow, &c. &c; and which render this object peculiarly elegant.

Of the singular movements of the blood after being taken from the body.—We have before noticed the singular contractile power of the flattened circular cakes in the blood (commonly though improperly termed globules), by which they adhere to each other in rows, like a heap of coin thrown down; but what we have now to notice is, that a minute drop of freshly drawn blood, being laid upon a slip of glass, and covered with a thin slice of talc, it will continue to flow for several hours afterwards, and will afford a most interesting object under the microscope. It, however, requires an excellent instrument to view it; we have found the single lens of our Varley's microscope, of the sixtieth of an inch focus, to answer perfectly. Sometimes the single cakes alone flow forwards in the serum, and frequently rows of the combined ones will be intermingled with them. What this very singular property may be owing to, is, we believe, yet unascertained; it may possibly be the curdling action of the blood, or that part of it termed the *crassamentum*, in separating from the *serum*, or more fluid part of it; at any rate it constitutes a highly interesting microscopic object.

Mr. Philip Carpenter's opaque solar microscope.—The fine sunshiny days during the latter end of last month, afforded Mr. P. Carpenter, of Regent-street, an early opportunity this spring of exhibiting this truly interesting instrument. He has been for some time occupied in preparing it, and the Editor was highly gratified in witnessing its effects a day or two since.

A beautiful shell was shown on a scale of at least seven

feet in diameter, its curious markings being well defined. A small peacock's feather was exhibited on a similar large scale, and its splendid irridiscent colours beautifully displayed. But the most splendid object of all was a diamond curculio, exhibited in all its astonishing brilliancy, and upon a scale of magnitude greatly exceeding any thing the Editor had hitherto seen.

His solar acromatic microscope for transparent objects, likewise displayed its usual powers; the curious instruments with which the bee collects honey, were shown on an immense scale, and every part of course distinctly visible. Mr. Thomas Carpenter had prepared this fine object for Mr. Philip Carpenter. The scales of the dace, and the curious reticulated ones of the trunk-fish, were beautifully shown; the latter, in particular, being very deeply coloured, proved the very superior powers of this fine instrument; as it required a very strong light to illuminate and render the curious markings visible. These markings very much resembled the cross-section of the pith of a rush, formerly given by us, consisting of hexagons, composed of triangles, ramifying in all directions. The compound cornea of the eye of a libellula, also formed a beautiful object. Neither were living objects wanting; the mites in cheese, the eels in paste, and various other animalculæ in water, were beautifully displayed. In particular, the larvæ of the dyticus or great water-beetle, were exhibited on a grand scale, and displayed tokens of their natural ferocity in seizing tad-poles, &c., two of them sometimes attacking the same tad-pole, and striving to obtain the sole possession of it; nay, when in want of other prey, they even frequently attacked each other.

Amongst the opaque objects, coins afforded very fine ones; a sovereign, for instance, filled the whole circular field of nine feet in diameter! It is, however, totally out of our power to convey any thing like an adequate idea of the real appearances which presented themselves in viewing the effects of this grand and unique instrument.

(*To be continued.*)

LXXI.—*On the Culture of the Begonia. By the* Editor.

It is now three years since the Editor had a present made him, in the beginning of winter, by a friend, of a single tuber of the Begonia, with instructions to plant it, and to keep it dry all the winter; and not to begin to water it in the spring until it began to manifest signs of vegetation, by throwing up shoots through the surface of the soil. He accordingly did so; and in the succeeding year, it grew and throve apace; and, at the latter end of the year, produced its beautiful pale red flowers, with bright yellow globular tufts of apices. Still no female flowers appeared; but, nevertheless, it produced tubers at every joint; and, on the first frosts attacking it, it fell to pieces, and the tubers separated of themselves.

He did not transplant it, but kept it dry all the winter in the flower-pot, in one of the apartments of his house; and, on the shoots appearing in the spring, he began to water it, still without transplanting it, or even adding any manure to the soil; as he thought that the rotted fibres of the last year's roots might prove sufficient to afford nutriment to the plant, and so it turned out. It throve exceedingly, flowered, and again threw off a crop of tubers on the approach of winter. He again suffered it to remain undisturbed in the pot, kept it dry all the winter, and it has just now pushed out numerous stems and leaves through the soil, and promises to flourish luxuriantly in the ensuing summer. It is now two years since the Editor planted two or three of his first crop of tubers, in the soil contained in a garden pot, and which soon vegetated, and produced fine plants, even flowering and producing other tubers in the course of the year; he managed these in a similar manner to the first; and he has now a third pot of young plants, the produce of last year's tubers; and which, indeed, from all the plants, amounted to upwards of a hundred, so readily is this beautiful plant propagated.

He was this year enabled to afford several of his friends

tubers of last year's growth, and which, at their usual period, had thrown out small pink coloured shoots; and, no doubt, by following these very easy instructions, they will be enabled to succeed in the culture of this beautiful plant, as well as the Editor.

Not having hitherto transplanted any of his plants; he has not availed himself of the great increase by the roots or tubers, produced beneath the soil, which is the usual mode of propagating them. He is not aware whether the gardeners in the vicinity of the metropolis have also planted the tubers produced from the stems; but it is evidently a rapid mode of increasing the number of their plants.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since March 30, 1830,

To John Rawe, Junior, of Albany-street, Regent's-park, in the county of Middlesex, being one of the people called quakers; and John Boase, of the same place, gentleman; for certain improvements in steam-boilers, and a mode of quickening the draught for furnaces connected with the same. Dated March, 30, 1830.—To be specified in six months.

To William Aikin, of Carron Vale, in that part of our United Kingdom called Scotland, esquire; for certain improvements in keeping or preserving beer, ale, and other fermented liquors. Dated March 13, 1830.—In six months.

To Daniel Towers Shears, of Bankside, in the borough of Southwark, in the county of Surrey, coppersmith,; for certain additions to and improvements in the apparatus used in distilling, and also in the process of distilling and rectifying. Dated March 31, 1830. In two months.

To James Collier, of Newman-street, in the parish of Saint Marylebone, in the county of Middlesex, civil engineer; and Henry Pinkus, of Thayer-street, Manchester-square, in the same parish, gentleman; for an improved method and apparatus, for generating gas for illumination. Dated April 5, 1830.—In six months.

To William Alltoft Summers, of Saint Georges in the East, in the county of Middlesex, engineer; and Nathaniel Ogle, of Millbrook, in the county of Hants, esquire; for certain improvements in the construction of steam engine and other boilers, or generators, applicable to propelling vessels, locomotive carriages, and other purposes. Dated April 13, 1830.—In six months.

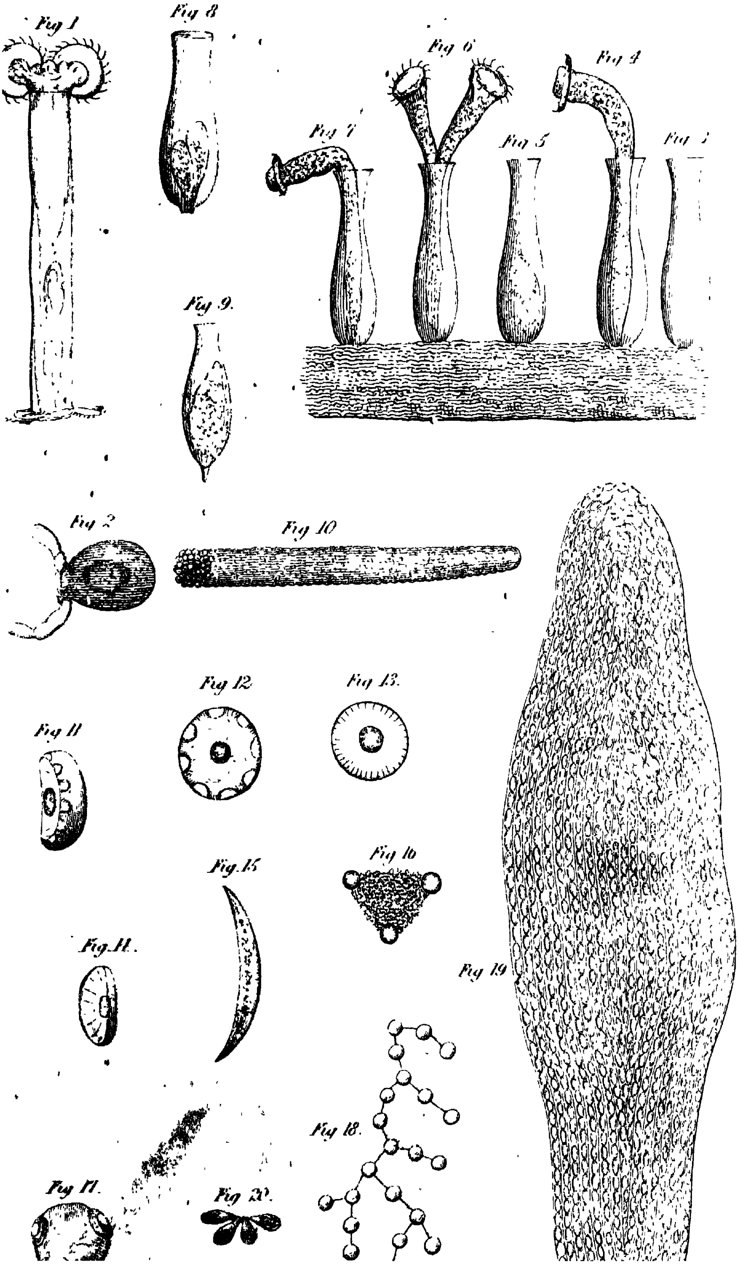
Fig 1
Fig 8
Fig 6
Fig 4
Fig 7
Fig 5
Fig 9.
Fig 2
Fig 10
Fig 12
Fig 13.
Fig 11
Fig 16
Fig 15
Fig 14.
Fig 19
Fig 18.
Fig 17.
Fig 20.

GILL'S

TECHNOLOGICAL & MICROSCOPIC

REPOSITORY.

LXXII.—*On the Microscope. By* Thomas Carpenter, *Esq. With Additions by the* Editor.

(*Continued from page* 318.)

WITH A PLATE.

SIR, *Tottenham, May* 10, 1830.

In the third volume of your *Technological Repository*, page 272, is contained à brief statement, which I furnished you with, of the devastations committed on various species of property, by the white ants. Alarming as these depredations appear, yet they fall infinitely short of the dangerous ravages made on the timbers of ships, &c., by various species of sea-worms. I herewith send you several portions of ship timber, which has been perforated by one particular species, *teredo navalis*; you will observe among the whole number of pieces that every part of the interior has been excavated by these animals. I wish to direct your attention to one of the pieces in particular, it being part of the false keel of a ship. The whole of the keel was perforated throughout in a similar manner to this piece. You will observe numerous minute openings on the under side, which were made by the animals whilst in their young state, in order to work their way into the interior; and, as they increased in size, they enlarged or scooped out their dwellings; the wood which they thus scooped out, serving them as food. They are also provided with two singular organs, by one of which they draw through the

holes they made at their entrance into the timber, the sea-water, in which they find animalcule which serve as their nourishment; the other organ is used by the animal to convey away the waste fluid through their intestinal canal, and which fluid carries off with it the portions of the wood, after the animals have extracted those virtues from it which are necessary for their sustenance.

This destructive animal is in general, when full grown, from four to six inches in length, of a grey colour, and about the thickness of the middle finger. It is covered with a very thin cylindrical and smooth shell, and has two calcareous hemispherical jaws, flat before, and angular behind. Great numbers of these worms, which are supposed to have been introduced from India into Europe, are, as before observed, found in the sides and bottoms of ships, so much so, indeed, as often to endanger them! It is said that our vessels never suffered from these enemies till within the last century, and that we imported them from the sea about the Antilles.

In the year 1730, the inhabitants of the United Provinces were under serious alarm concerning these worms, which had made dreadful depredations in the piles that support the banks of many parts of those coasts. One of the persons who had the care of the Dutch coasts at that time, observed, to his astonishment, that some of the timbers were, in the course only of a few months, made so full of holes, that they could be beaten in pieces with the least force.

The perforations, when the mud was scraped off, did not appear much larger than to admit a pin's head to be thrust into them. A very thin piece of whalebone being put into one of these, would enter straight forward for three or four lines, and the holes then generally for some distance farther proceeded upwards. One of the piles being split lengthwise with a hatchet or wedge, was found full of passages, or hollow cylindrical ducts, each of which contained a worm, enclosed in a kind of testaceous tube or covering, of

a white colour, which it exactly filled, but in such a manner as to be able to move with freedom. This tube was found straight or bent, according to the form of that part of the hole where the animal was employed. The holes at the outer surface were very narrow, but increased in width within, evidently as the worm increased in size. They were never found to run into each other, but all to proceed separately. It was happily discovered, a few years afterwards. that these creatures had totally abandoned these coasts. Thus a contemptible worm, multiplying beyond its usual limits, is capable of destroying the most boasted efforts of human industry! No contrivance has yet been suggested by human ingenuity that has been found fully sufficient to prevent the formidable ravages of these animals.

When Professor Thunberg was in Japan, he observed the manner in which the Japanese contrived to preserve their vessels against the ravages of this destructive worm. This was, simply to drag them on the strand, and burn the sides of them as high as the water usually reached, till they were well covered with a coat of charcoal.

The head of this creature is well prepared for the office of boring, being coated with a strong armour, and furnished with two sharp instruments, by means of which it scoops out the wood. The neck is provided also with muscles of great strength. It is very minute when it first issues from the egg; but, as before observed, grows to the length of near six inches. This tribe of animals generally act gregariously, and take especial care not to interfere with each other's cells or habitations; externally, the opening is scarce visible; but when they have committed their depredations, on taking off a layer of the plank, the whole interior exhibits a honeycomb-appearance, and is generally entirely destroyed. In some sense, this tribe may be said to co-operate at sea with the labours of the *termes fatali*, or white ants, on land. While, however, it commits enormous mischief on the labours of the shipwright, it also effectually removes those obstructions in rivers, and even in

many parts of the ocean itself, which would otherwise ensue from such immense quantities of trees as are often washed down by rapid torrents from the mountains, and which would otherwise remain in a state of perfect preservation under water for centuries.

I now proceed to inform you, that I succeeded in the idea I mentioned to you, of constructing a small pond in my garden here, for the purpose of breeding various species of aquatic insects; and, at the same time, of observing their various changes from the eggs to the perfect insects. I shall, from time to time, note down those interesting operations in nature, and furnish you with the result of my experiments and observations. In the mean time I herewith send you a few phials, containing water from the said pond, in which you will find some singular species of monoculi and polypes; also the *volvex globator*, and the larvæ of various species of gnats, together with many other singular aquatic animals, in many of which you may observe the circulation of the blood in a very distinct manner, particularly in the fins or feet of the small water newt, the tail of a young tadpole, &c. &c.

You will observe several minute shells, to which are attached clusters of the *vorticella*, or bell-shaped polype. There are also other species of these polypes, viz. *vorticella convallaria*, attached to the stems of some duck-weed, which you will find within the bottles. The most elegant of which is the *vorticella racemosa*; you will find a fine specimen of it attached to a small spiral snail shell, and the extraordinary structure of which is singularly curious. From a single stem proceeds at various distances several smaller ramifications, each terminated by an apparent flower, like that of a convolvulus, and furnished on the opposite edges with a pair of filaments resembling stamina, the varying motions of these seeming flowers expanding and contracting occasionally, and turning themselves in different directions, is one of the finest spectacles which the microscope is capable of exhibiting. To the naked

eye, these clusters appear only as so many little white specks of slime or mouldiness; but under the microscope, as little bells, with long stems, which are attached to the snail shell and duck-weed, agitating the water to a considerable distance. The stems of these polypes have a peculiar motion; they draw themselves up and shorten all at once, taking the form of a spiral; in a moment after, they again resume their former shape, stretching themselves out as straight as before. You will find it highly interesting to watch the motions of these minute specks under your microscope, and also to observe the manner in which they catch their prey.

Among the larvæ in the phials, you will find those of the common gnat, *culex pipiens*. As this species has afforded us many interesting microscopic objects, in the dissection of the instruments contained within its proboscis; the characters in the numerous scales with which it is adorned; and its various other parts, which have been described by me in former letters to you on the subject; and also as few insects are better known than this species of gnat; so its history, I presume, may not prove uninteresting. Divine Providence instructs the insect tribes in a most remarkable manner to deposit their eggs, not only in safety from their numerous enemies, but also in situations where a sufficient quantity of food is on the spot to support and nourish the larvæ, immediately on breaking the shell. The gnat hovers over the water during the day, to drop its eggs, which are hatched in the water, and the insects continue there all the time they are in the larva form. The mass of eggs formed by it, resembles a little vessel set afloat by the insect; each egg is arranged in the form of a keel, and all are curiously connected together. The gnat lays but one egg at a time, which she deposits on the water in a very ingenious and simple manner; she stretches her legs out, and crosses them, thus forming an angle, to receive and hold the first egg; the second egg is soon placed next the first; then a third, and so on, till the base is capable of supporting itself:

these, as they come to maturity, sink deeper. The mass of spawn of this insect is sometimes above an inch long, and one-eighth of an inch in diameter, and is tied by a little stem or stalk to some stick or stone. Sometimes they are laid in a single, and sometimes in a double, spiral line; and again, sometimes transversely. When the eggs arrive at maturity, the young grubs or larvæ come forth, and commence feeding on the smaller aquatic insects. Were the gnats not kept under, by being devoured by the larger aquatic animals, when in the larva state, and also by swallows and other birds, when in the winged state, the air would often, from their immense multitudes, become darkened; many instances having indeed occurred in which this has been the case. In the larva state they may be observed in stagnant waters from the beginning of May until winter, with their heads downwards, their hinder part floating on the surface of the water; this is divided into two parts, of very different forms; by one of these it can steer itself in any direction; in the other, two pulmonary tubes may be discovered through which the insect breathes.

The larva has the power of moistening its tail with an oleaginous liquor, by which means it can suspend itself on the surface of the water. On agitating the water, the worms or larvæ descend with precipitation to the bottom, but they soon return to the surface again to breathe the air through the tube that is annexed to their tail. The head is armed with hooks that serve to seize on insects, and the bits of grass on which it feeds. These larvæ retain their form during a fortnight or three weeks, after which period they pass into the pupa state. All the parts of the winged insect are now distinguishable through the outward robe that shrouds them. These pupæ are rolled up into spirals. The situation and shape of the windpipe is then altered; it consists of two tubes near the head, which occupy the place of the stigmata, through which the winged insect is to breathe. In this state they keep constantly on the surface of the water, in order to draw in

breath, and now abstain from eating; but upon the least motion they are seen to unroll themselves and plunge to the bottom, by means of little paddles, situated at their hinder part. After three or four days fasting, they pass into the state of gnats. A moment before, water was its element; but now, become an aërial insect, it can no longer exist in it! It swells its head and bursts its enclosure. The robe it lately wore turns to a ship, of which the insect is the mast and sail. If, at the instant the gnat displays its wings, there arise a breeze, it proves to the insect a dreadful hurricane; the water gets into the ship, and the gnat, who is not yet loosened from it, sinks and is lost. But, in calm weather, the gnat forsakes his slough, dries himself, flies into the air, and seeks to suck either the alimentary juices of plants, or the blood of men and beasts. The sting, which our naked eye discovers, is but a tube, containing five or six spiculæ of exquisite minuteness; some are dentated at their extremity, like the barb of an arrow; others sharp edged, like razors. These spiculæ, when introduced into the veins, act as suckers, into which the blood ascends, by reason of the smallness of the capillary tubes. The insect injects a small quantity of liquor into the wound, by which the blood becomes more fluid, and is seen, under the microscope, passing through those spiculæ. The insect swells, grows red, and does not quit its hold till it has gorged itself! The liquor which it has injected causes, by its pungency, that disagreeable itching which we experience; but which, however, may be removed by volatile alkali, by laudanum, or by washing the part in cold water.

The minute but truly formidable apparatus by which this insect annoys us, may be deemed the most curious set of instruments among the insect creation; and, in consequence of their minuteness, I consider they exceed, in perfection, those I furnished you with, and which I dissected from the proboscis of the *tabanus*, as described in the third volume of your work, page 260, plate VII.

The curious and compound structure, together with the

wonderful forms, and exquisite beauty of the apparatus contained within the proboscis of the gnat and of the *tabanus*, display such a view of the wisdom, power, and greatness of its infinite Composer, as must strike with admiration every contemplative observer, and lead him to reflect on the weakness, impotence, and nothingness of all human mechanism, when compared with the immense skill and inimitable finishing displayed in these objects of our wonder.

The musqueto fly is nothing more than a larger variety of the common gnat, which is very common in the woody and marshy parts of all hot climates. Its bite is so severe, as to swell and blister the skin in a most painful manner, and sometimes even to leave obstinate sores. Seeking its food principally in the night, it disturbs the rest of persons nearly as much by the buzzing noise it makes with its wings, as by its bite. The poor inhabitants of some of the low parts of the West India islands are under the necessity of burning a fire continually in their huts, by the smoke of which these insects are effectually kept at a distance; but persons who can afford it sleep under nets of thin gauze.

The gnat itself viewed either as a whole, or in its separate parts, affords interesting spectacles under the microscope; and, in order that you may examine them under your instrument, I have displayed two very fine specimens of the insects on pins, in such situations as will enable you to examine them in the above manner. One of these alighted on my hand last summer, and remained stationary for a considerable time, which gave me an opportunity of examining its method of piercing and sucking the blood through the fine capillary tubes which are contained within the sheath of its proboscis.

By using the hand magnifier, I observed it feeling about with its proboscis, for a proper place where to insert its lancets; as soon as it had discovered this, it separated one of its piercers, and plunged it into the part, which caused a smarting pain, owing to the action of the corrosive fluid, which it injected into the wound; it then withdrew the

piercer, and introduced a short tube, through which it sucked the blood for the space of two minutes, and having filled its stomach, flew away to the window, where I caught it, and set it out for the purpose of examining its various parts. The wings you will find ornamented with a fringe of feathers or scales, as are also the ribs of the wings. The wings, when viewed as transparent objects, present a most interesting spectacle; but when viewed under the opaque speculum, and placing a black ground behind them, they present to the eye of the observer the most splendid colours, equalling some of the most brilliant specimens of minerals! The horns are also fine objects, so also are the head, eyes, and legs; in short, there is no part of this insect but is highly interesting in the examination! Every part of it is profusely ornamented with scales or feathers, varying in their characters from each other, according to the part from whence they are taken. Each of these deserves minute inspection under the microscope, in order to discover the beauties with which this insect is adorned. You will perceive I have separated the lancets, &c. from the sheath, for your examination: these instruments will require a very high power to discover their shape and characters.

Before I dismiss this subject, I beg to give a very interesting extract from Kirby and Spence's Entomology, respecting the manner in which the female gnat deposits its eggs, and which I copy from page 81 of the third volume of that work.

" The eggs of this insect, of a long phial-like form, are glued together, side by side, to the number of from two hundred and fifty to three hundred, into an oblong mass, pointed and more elevated at each end, so as considerably to resemble a little boat in shape. You must not here suppose that I use the term *boat*, by way of illustration merely; for it has all the essential properties of a boat. In shape, it pretty accurately resembles a London wherry, being sharp and higher, to use a nautical phrase, fore and aft; convex below, and concave above; floating, more-

over, constantly on the keel or convex part. But this is not all. It is, besides, a *life-boat*, more buoyant than even Mr. Greathead's: the most violent agitation of the water cannot sink it; and what is more extraordinary, and a property still a desideratum in our life-boats, though hollow, it never becomes filled with water, even though exposed to the torrents that often accompany a thunder-storm. To put this to the test, I yesterday (July 25, 1811), placed half a dozen of these boats upon the surface of a tumbler, half full of water; I then poured upon them a stream of that element from the mouth of a quart bottle, held a foot above them. Yet, after this treatment, which was so rough as actually to project one out of the glass, I found them floating as before, upon their bottoms, and not a drop of water within their cavity.

"This boat, which floats upon the surface of the water until the larvæ are disclosed, is placed there by the female gnat. But how? Her eggs, as in other insects, are extruded one by one. They are so small at the base in proportion to their length, that it would be difficult to make them stand singly upright on a solid surface, much more on the water. How then does the gnat contrive to support the first egg perpendicularly, until she has glued another to it? These two, until she has fixed a third, and so on, until a sufficient number is fastened together to form a base, capable of sustaining them in their perpendicular position. This is her process. She fixes her four anterior legs upon a piece of leaf, or a blade of grass, and projects her tail over the water; she then crosses her two hind legs, and in the inner angle which they form, retains and supports the first laid egg, as it proceeds from the anus. In like manner she also supports the second, third, &c., all of which adhere to each other by means of their glutinous coating, until she feels that a sufficient number are united to give a stable base to her little bark. She then uncrosses her legs, and merely employs them to retain the mass until it is of the required size and shape, when

she flies away, and leaves it to its fate, floating upon the water."

As the water in various ponds now abounds with highly interesting microscopic objects, so I would recommend you during the summer, to search such as are near London. I feel no hesitation in saying that you will be amply repaid for any trouble you may take, by the discovery of many singular and undescribed water insects. Many persons are apt to treat with contempt any man whom they see employed in poring over a moss, or examining an insect, from day to day, thinking that he spends his time and his life in unimportant and barren speculations; yet were the whole scene of nature laid open to our view, were we admitted to behold the connections and dependencies of every thing on every other, and to trace the economy of nature through the smaller as well as greater parts of this globe, we might, perhaps, be obliged to own, that we were mistaken, that the Supreme Architect had contrived his works in such a manner, that we cannot properly be said to be unconcerned in any one of them; and therefore that studies, which seem upon a slight view, to be quite useless, may in the end prove of no small importance to mankind. Nay, were we only to look back into the history of arts and sciences, we must be convinced, that we are apt to judge over hastily of things of this nature. We should there find many proofs that He who gave this instinctive curiosity to some of his creatures, gave it for good and great purposes, and that he rewards with useful discoveries all these minute researches.

Stillingfleet, in his work on the Œconomy of Nature, very justly observes: "From a partial consideration of things, we are very apt to criticise what we ought to admire; to look upon as useless, what, perhaps, we should own to be of infinite advantage to us, did we go a little farther; to be peevish where we ought to give thanks; and, at the same time, to ridicule those who employ their time and thoughts in examining what we were, *i. e.* some

of us most assuredly were, created and appointed to study. In short, we are too apt to treat the Almighty worse than a rational man would treat a good mechanic, whose works he would either thoroughly examine, or be ashamed to find any fault with them. This is the effect of a partial consideration of nature; but he who has candour of mind, and leisure to look farther, will be inclined to cry out—

How wond'rous is this scene! where all is form'd
With number, weight, and measure! All design'd
For some great end! where not alone the plant
Of stately growth; the herb of glorious hue,
Or food-full substance; not the labouring steed,
The herd, and flock that feed us; not the mine
That yields us stores for elegance and use;
The sea that loads our table, and conveys
The wanderer man, from clime to clime; with all
Those rolling spheres, that from on high shed down
Their kindly influence: not these alone,
Which strike ev'n eyes incurious; but each moss,
Each shell, each crawling insect holds a rank
Important in the plan of Him, who fram'd
This scale of beings; holds a rank, which lost
Wou'd break the chain, and leave behind a gap
Which nature's self would rue. Almighty Being,
Cause and support of all things, can I view
These objects of my wonder; can I feel
These fine sensations, and not think of Thee?
Thou, who dost through th' eternal round of time;
Dost through th' immensity of space exist
Alone, shalt Thou alone excluded be
From this thy universe? Shall feeble man
Think it beneath his proud philosophy
To call for thy assistance, and pretend
To frame a world, who cannot frame a clod?—
Not to know Thee, is not to know ourselves—
Is to know nothing—nothing worth the care
Of man's exalted spirit—All becomes,
Without thy ray divine, one dreary gloom;
Where lurk the monsters of fantastic brains,
Order bereft of thought, uncaused effects,
Fate freely acting, and unerring chance,
Where meanless matter to a chaos sinks,
Or something lower still; for without Thee
It crumbles into atoms void of force,
Void of resistance—it eludes our thought.

Laws eternal, to the varying code
Of self love dwindle. Interest, passion, whim,
Take place of right, and wrong; the golden chain
Of beings melts away, and the mind's eye
Sees nothing but the present. All beyond
Is visionary guess—is dream—is death!"

I remain, dear Sir,
Your obliged friend,
THOMAS CARPENTER.

To T. GILL, *Esq.*

Postscript.—I have been employed in selecting a few objects, which I trust, on examination, you will find interesting. I have before observed, that the tribes of moths and butterflies afford a very fertile field to make additions from for your collection; and among the whole, I know of none that exceed for curious and beautiful characters, the family of *Lycæna.* It comprises fourteen species; some of them exceedingly rare, and the scales from most of them are fine test objects. I have, therefore, placed a few scales or feathers from each of the species between glass slips, which I herewith send for your examination. They are as follows:—*Lycæna Adonis,* the Clifden blue; *L. Alsus,* the Bedford blue; *L. Argiolus,* the azure blue; *L. Argus,* the studded blue; *L. Arion,* the large blue; *L. Artaxerxes,* the white spot brown, or Scotch Argus; *L. Chryseis,* the purple-edged copper; *L. Corydon,* the Chalk-hill blue; *L. Dispar,* the large copper; *L. Dorylus,* the common blue; *L. Idas,* the black spot brown; *L. Phlæas,* the small copper, or common copper; *L. Virgaurea,* the scarce copper, or middle copper; and *L. Cymon,* the Mazarine blue.

Additions. By the EDITOR. *And References to the Plate.*

On the Wheel Animalcule.—In the beginning of last month (May), the Editor placed in water, under his Varley's microscope, having a single lens, of the twentieth of an inch focus, some leaves of an aquatic plant, from one

of which a straight and nearly opaque tube projected, and at the outward end of it the head and wheels of a wheel-animalcule appeared, with a distinctness superior to any he had ever seen before ; as the head of the animalcule was completely stationary, whilst the wheels were in motion, and it was indeed difficult not to believe, that a single tooth of a wheel could not be traced along, during a great part of its revolution ; only that such a thing must be an impossibility, so complete was the deceptive appearance of it ! Fig. 1, of plate VI., exhibits the tube, and the wheel-animalcule.

It would seem that the wheel-animalcule had constructed this tube for its abode, as its body completely fitted it, with the exception of an egg, which could also be seen within the tube.

On the Editor's shallow Ponds.—The above-mentioned beautiful object was placed on a slip of glass, having a very thin border of sealing-wax laid along each of its edges, near the middle of it, whilst the glass was heated, and two lines of sealing wax crossing over its surface, from the ends of those borders, and thus forming one of the square shallow ponds before described in these articles on the Microscope. A little water containing animalcules, &c., being laid in this pond, with the help of a small feather, the whole was covered with a thin slip of Bohemian plate glass, and thus rendered this highly interesting object completely manageable under the microscope.

A similar pond may also be formed by making a circular narrow and thin ring, or border of sealing-wax, upon the middle of the surface of a glass slip, when heated over the flame of a candle sufficiently to melt the sealing-wax ; and which will answer the same purpose of confining the water within due bounds ; and these ponds, and their glass covers, being thus formed of two separate glass slips, admit of being wiped clean with great facility ; an advantage which, however, cannot be derived from the narrow cells, formed of two slips of glass cemented very near together at three of

their edges, with sealing-wax, and which retain water between them, even when laid in a horizontal position, by reason of the capillary attraction.

On a new Animalcule.—A most singular appearance presented itself to the notice of the Editor on the 17th ult. He was engaged in viewing the animalcules in water, laid between two glass slips, as above described, and observed a transparent larva of a gnat to have an oval dark-coloured opaque body in its stomach, and which, on a more accurate inspection, appeared to be continually revolving slowly within the body of the larva, to its great annoyance, as it frequently moved itself by sudden starts. He shortly afterwards found in the field of view another similar dark oval body, and which he would have overlooked under ordinary circumstances, as conceiving it probably to be the egg of some insect; however, upon closely examining it, he found it to move slowly about, and perceived that it protruded from an aperture in its front, a delicate kind of feelers, by means of which it moved itself slowly in various directions. Fig. 2 represents this animalcule, as viewed under the power of a single lens, the twentieth of an inch focus. Its feelers, however, assumed a great variety of very different shapes; and, shortly afterwards, the Editor found that the one he saw in the stomach of the larva had worked its way out again uninjured, and left the body of the larva as transparent as it usually is.

On Polypes inhabiting transparent cells.—The Editor, pursuing his researches amongst the confervæ, vegetables, and animalcules which contained the above-mentioned wheel animalcule lying in its tube, found, adhering to some old confervæ, the singularly shaped transparent cells containing polypes; and of which an empty one is shown in fig. 3. Fig. 4 exhibits one with the polype stretching itself out at the mouth of its cell, and seeking its food. Fig. 5 shows it as shrunk into its cell. Fig. 6 exhibits two polypes inhabiting the same cell. Fig. 7 shows one stretching itself over the margin of its cell, the rigidity of which

has indented itself in the softer body of the polype. And Fig. 8 shows a cell, disjoined from any attachment to any other body, with two polypes shrunk up within it. Fig. 9 is the cell of a smaller species of polype, several of which adhered by slender stems to the exuvia of a fresh water shrimp, the polype is seen as shrunk up or contracted within the cell.

On a tube formed of minute eggs of animalcules.—Fig. 10 is a highly magnified view of this tube, the globular form of the eggs composing which is only to be seen in those at one end of the tube, which are transparent; the rest of the tube being of a deep brown colour.

Figs. 11 and 12 represent a front and edge view of the shell of an egg of an animalcule, and which is of a brown colour. It has an orifice in its centre, and a number of indentations surrounding it.

Figs. 13 and 14, are front and edge views of the shell of another egg, similar to that above-mentioned; but in which none of the indentations found in that shell are seen.

Fig. 15 represents a crescent-shaped green animalcule, also found with the above-mentioned objects.

On the farina of the African marygold.—Fig. 16 is the farina of the African marygold, viewed in water; the three vesicles at the corners are white and transparent, but the rough part of it is of a brown colour.

On one of the globules of the farina of the lime-tree.—Fig. 17 represents this object, also viewed in water. These shot out their pollen at the three apertures in their corners; and, upon the water drying up, they remained linked together in the singular manner represented in fig. 18.

On the scales of the Chameleon.—Fig. 19 is a magnified view of a curious scale, forming one of the rarities in Mr. Thomas Carpenter's valuable collection of microscopic objects. It is composed of lines in rows, following the outline or contour of the scale, and between them small circular bodies are interposed. It is indeed of a most singular and

beautiful structure, and much resembles the minute scales of eels. Mr. Philip Carpenter having, however, expressed some doubts as to the fact of the chameleon having scales, as he had never seen any upon a specimen of one which he possessed; and Mr. J. Gray, of the British Museum, not being able to satisfy the Editor's mind upon this subject, he stating, that although the chameleon was covered all over with small granular bodies, yet he had never noticed any appearance of scales similar to that the Editor exhibited to him. On this the Editor determined to remove all doubt upon the subject, by going over to Mr. Thomas Carpenter, at his new residence at Tottenham, and stating these circumstances to him; on this, he immediately produced his dried specimen of a chameleon, and showed the Editor several places from which the olive green coverings of the granules had been removed, and also several of these coatings or scales still lying loose in the immediate neighbourhood of those denuded places. Some of these he put into water, and, upon their extending themselves on becoming moist, he placed them between two glass slips, and bound the slips tightly together. Upon becoming dry, several of them assumed the linear appearance exhibited in our figure, in shrinking or contracting, and all of them showed the small circular bodies above mentioned. There can now, therefore, be no manner of doubt as to the fact of the chameleon possessing these curious scales, and the Editor is indebted to the scruples expressed by his friends for the realization of this curious fact in Natural History.

Fig. 20 exhibits a few minute eggs of an animalcule, highly magnified, in each of which a number of exceedingly minute vesicles are seen.

On the circulation of the blood in the young of the newt.—Mr. Thomas Carpenter kindly gratified the Editor with a sight of this beautiful appearance, in the projecting fringes, which are found on each side the body of this young newt, near its head, and before its legs are formed;

the blood circulating most briskly throughout all their ramifications, and being very distinctly seen, under a moderately magnifying power, on account of the great transparency of the skin covering those fringes. We cannot too strongly call the attention of our readers to this interesting subject at the present time, when, only, the young of the newt are to be found in great abundance.

On Mr. T. Carpenter's apparatus for catching larvæ, newts, &c.—The above mentioned visit to Mr. Carpenter, afforded the Editor an opportunity of seeing this apparatus. In a covered basket such as anglers use, he carried several wide-mouthed bottles, a spoon, and a flat shallow tin vessel, painted white in its inside, and having a socket affixed to one side of it, into which a walking-stick could be introduced, to serve as a handle to it. With this vessel Mr. Carpenter took up portions of the water from ponds, rivers, &c., in which he expected to find any of the various objects, and, if he succeeded in his aim, he transferred them, with some of the water, by means of the spoon, into one of the bottles, for future examination.

We need hardly dwell upon the great value of a taste for Entomology and Natural History, as connected with the employment of the microscope, to aid in occupying the time of a gentleman residing in the country, and entirely removing the complaint of *ennui*, so frequently experienced by those who have no such delightful sources of enjoyment. It must be obvious to our readers.

(*To be continued.*)

LXXIII.—*On Regulating Heat. By* J. M'Sweeny, *M.D.*

SIR, *Cork, April* 16, 1830.

The great object of science should always be to improve the arts that tend to the good of mankind, and attention should be particularly directed to subjects of practical utility. In no way has science been more usefully em-

ployed than in endeavouring to obtain control over heat, an agent so subtile and transient, as to seem incapable of being confined, without the constant care of an attendant, within a certain narrow limited range, necessary in many delicate processes of the arts.

But now an artificial atmosphere can be constantly kept regulated in apartments fit for invalids, and for all useful purposes, even for the rearing, on a large scale, of silk-worms, in the variable climate of England, a matter of national importance. The temperature can be kept steady by self-adjusting apparatus, acting with unerring precision.

In M. Bonnemain's French mode of warming apartments, of which a description and plate are given in the *Technological Repository*, vol. II., for 1828, the regulator of the heat acts on the register door of the furnace of the boiler, which supplies with water, of a certain temperature, the tubes convoluted about the apartment. The regulator of the heat which I have described in my last communication, acts also on the register door of the furnace. The water in the boiler, therefore, can never rise above a certain regulated temperature, and the boiler acting in this way cannot be available for ordinary domestic purposes. To make a common boiler and furnace regulate the heat of a distant body of water employed as a bath, or circulating in tubes through a fermenting liquid, so as to keep the fermenting liquid at an uniform temperature, was a problem that engaged my attention some time ago, and the plan I proposed for that purpose has been published in the Dublin Philosophical Journal.

The object of this paper is to point out a preferable mode, by which the same desirable end may be obtained. The regulator acts by supplying the bath or body of water, the temperature of which is to be regulated, with warmer water from a higher level, exactly in proportion as the bath cools; and by cutting off the supply of the warmer water, the moment the necessary temperature is obtained. I need

not descant on the advantage of such regulated baths for the use of delicate persons: in hospitals, I hope, they will be generally adopted.

In a bath, the temperature of which is to be kept constantly uniform, a regulator, being a tube bent in the form of the letter L, is to be immersed, with a bulb containing air or gas. On the liquid in the tube of the regulator is a float; the liquid confines the air or gas in the bulb. The end of a lever is connected with the float, by means of a wire, that rises through a stuffing-box, and a cup of oil, at the top of the tube of the regulator. The other end of the lever is connected with a valve, placed at the mouth of a tube, that descends from the reservoir of hot water. The supply of hot water in the reservoir is kept up by an adjoining boiler, which may be made available to any useful purpose.

The regulator acts in this way; the air or gas in the bulb contracts in proportion as the bath cools. When the air contracts in the bulb, the float descends in the tube of the regulator, and pulls down, by means of the wire, the lever; the opposite end of the lever rises, and opens the valve in the reservoir, and allows hot water to descend to raise the temperature of the bath to the proper height. When an increase of temperature has taken place in the bath, the air or gas in the bulb of the regulator expands again, the float rises, and the lever returns to its former horizontal position, when the degree of heat for which it was set is obtained. The lever may be adjusted to keep the water at different degrees of temperature, as it may be required, by adding small weights to bring it to the horizontal position; when in this position the supply of hot water is cut off by the valve, until wanted by the cooling of the bath. Thus the regulator admits as much hot water as will keep the bath at the desired temperature, and no more.

As every addition of hot water from the reservoir has a tendency to raise the level of the boiler in the bath, and as

the colder portion of water always tends to accumulate at the bottom, a waste pipe which ascends from the lower part of the bath discharges the coldest portion of the water exactly in proportion as the hot water is added. In this way the process constantly goes on with unerring exactness, without the care of an attendant, and without any complicated machinery; and the regulator, from its simple construction, is not liable to get out of order.

The temperature of the water discharged by the waste-pipe, will always bear a proportion to the temperature of the bath. Thus, if by adjusting the lever of the regulator, we raise the temperature of the bath, the heat of the water discharged by the waste-pipe will be also proportionally increased; in this way we can have control over the temperature of the water discharged; and instead of allowing it to go waste, we can cause it to circulate through a worm to regulate the heat of fermenting liquids, or we can conduct this water through tubes convoluted about an apartment, and can in this manner regulate the temperature of the apartment with great exactness.

The different useful applications of regulated heat, will naturally suggest themselves to persons conversant in the arts; it would, indeed, be an endless detail to point out all the purposes for which it might be used. The gardener can calculate with certainty on the heat of his hot-house; even the farmer, on a large scale, can have recourse to water, of a regulated temperature, in convoluted tubes, passing through heaps of moistened peat, mixed with weeds or wet straw, in experiments for fermenting that obdurate substance, in order to change it into a manageable manure; or he may employ water in a similar manner, in tubes, to keep his dairy at the temperature best fitted for the production of butter. In the process of dyeing, a bath kept of a steady temperature, by means of hot water, would be a matter of no small importance. When a heat is required greater than is afforded by heated water, we can have recourse to oil; and the temperature of a bath of hot

oil can be kept steady, by adjusting the lever of the apparatus for the increased temperature; the regulator acts on the same principle when either oil or water is employed; thus we can regulate the heat of places fitted for annealing glass and for other purposes. The regulator, when it contains hydrogen or nitrogen in its bulb, instead of common air, can also be made in the same manner as is described before, to keep the heat of a metallic bath at the exact point fitted for tempering instruments of steel; but the material composing the regulator should be suited for immersion in the metallic bath in this case.

Nothing is of more general utility in the arts than a steady regulated heat, and the control which can now be obtained over it for useful purposes, must be equal to the expectations of the most sanguine: probably Count Rumford, when engaged about his favourite subject, *heat*, never imagined that in many very delicate processes in the arts, this subtile agent could be supplied in the exact proportion required, and by an apparatus which, when once adjusted, requires no further care from an attendant.

A regulator of the same form as for a bath, but not surrounded by water, and placed high up in an apartment, in order to open or shut a valvular ventilator moving on a horizontal axis in the cieling, would be found useful in places of public resort. The air of the place when heated by a number of persons crowded together, would cause the air or gas contained in the bulb of the regulator to expand; the liquid contained in the tube of the regulator would then ascend, the float on this liquid would consequently rise, and allow the ventilator to which it should be connected to open, for the purpose of allowing the heated air of the apartment to escape. It would be necessary to have the regulator for the purpose now mentioned, made of copper, a good conductor of heat, in order that the air or gas enclosed in the bulb might be quickly affected by any change of temperature in the apartment.

Heated air, conducted by tubes, is employed by many

to heat apartments; the quantity of heated air admitted into an apartment may be regulated by means of the copper regulator described; it will be only necessary to connect the balanced lever with a throttle valve in the hot air tube. A fall of temperature in the room will affect the regulator, and thus, by means of the lever, will open the throttle valve, and will allow more heated air to enter. When steam is employed in tubes to heat a room, a similar regulator and throttle valve will answer.

In my last communication, I suggested the employment of a similar regulator of copper, having its bulb exposed to the radiant heat of a furnace, for the purpose of acting, by means of its lever, on the register door of the furnace, to admit or cut off the supply of air, so as to keep the furnace at an uniform temperature.

Chemists are anxious to measure the degree of heat of a furnace, which is found to answer for any particular process, by reference to a known standard, that they may be able to obtain the same degree of heat again at another time, or with any other furnace, hence the different attempts to construct pyrometers. The pyrometer on the principle of radiation, which I described in my last communication, will, I believe, be found the most convenient in practice, and the most to be depended on, in estimating the heat of a furnace by the scale of the thermometer, as the radiation from a hot body bears a proportion to the heat of the hot body, and as the instrument is not liable to be injured by the fire.

The radiation pyrometer not being employed in contact with the fire, is capable of being also used to measure the heat of bodies, with the temperature of which we are already acquainted. Thus we may put the accuracy of the instrument to the test, and by placing it at different distances from surfaces of different and known temperatures, we can see if the law which is generally supposed to govern the radiation of heat, holds good in every case. When, for instance, we place the side of a canister containing

boiling ether, or the side of a similar canister containing boiling alcohol, at a fixed distance opposite the pyrometer, we mark the effects these boiling liquids produce on the instrument, above the effect caused by the mean temperature of the room. We know the difference between the heat of these boiling liquids, and can calculate the effect which a canister of boiling water, or a canister of boiling oil, ought to produce on the instrument, placed at the same distance We estimate afterwards the heat of a plate of iron red hot, or of a white heat, by comparing the effects produced by it on the pyrometer at a fixed distance, with the effects produced by vessels containing different boiling liquids of known temperatures at the same distance. We estimate the cause by the effects. Though we cannot plunge a thermometer into a fire, to measure the heat, yet we may deduce indirectly, in this manner, what the amount of the temperature of a plate of red hot iron is.

The mode of regulating the heat of liquids, described in this paper, will, I hope, come into general use; it is cheap, simple, and unerring in principle. To describe all the useful purposes to which it might be applied, would be to write a treatise on our arts and manufactures. When we have the heat of liquids regulated, it follows as a natural consequence, that we can regulate the temperature of apartments through which these liquids are made to circulate in convoluted tubes. Count Rumford has shown an example of what may be done by persevering attention to particular branches of science. The desire he evinced of encouraging efforts at useful applications of heat to the common purposes of life, has been productive of service: other branches of science might be promoted by similar means.

I think that the application of artificial heat, for the purpose of causing decomposition in heaps of moistened peat, mixed with recent vegetable refuse, is worthy of the attention of the agriculturist; peat, which is found in such abundance, is of itself not very friendly to vegetation, but

when mixed even with clay; good effects arise from it to the farmer.

A valuable product is obtained from layers of peat and of stable manure, or of recent vegetable matter, when allowed to heat in heaps.

As by means of the regulator, described in this paper, the temperature of water circulating in tubes can be regulated to any degree of nicety, and the tubes can be made to pass through heaps of any substance, and in any direction; so the decomposition of peat, mixed with other matters, may be promoted quickly, and on a large scale, in the hands of an agriculturist of enterprise and capital.

The rearing of silk-worms in England, in apartments, the temperature of which can be regulated with great accuracy, ought to be encouraged on a large scale. It will be a victory of science over the obstacles of climate, if English raised silk shall, at a future period, compete in a British market with the produce of a warmer clime. This application of artificial heat is of national importance, and ought not to be lost sight of.

The temperature exactly suited to the silk-worm can be maintained in an apartment by means of tubes, through which heated water circulates; the heat of the apartment will depend on the heat of the water, and the heat of the water will be in proportion to the adjustment of the regulator.

The regulator, which is shaped nearly in the form of the letter L, may be used in two ways; the wire from the float may be connected with the end of the lever, without passing through a stuffing-box; in this case the friction of a wire passing through a stuffing-box is avoided; but the tube being open to the action of the atmosphere, the level of the water in the tube is liable to be diminished by evaporation, if water be used; oil, therefore, or mercury, may be substituted as the liquid for confining the gas in the bulb of the regulator. The expansion and contraction of the gas

in the bulb is subject to be influenced by the diminution or increase of atmospheric pressure, when the tube is open to the action of the atmosphere; therefore when a change is indicated by the barometer, the lever would require some adjustment, by changing its small weights.

When the wire passes through a stuffing-box and a cup of oil, the friction from a smooth wire is not much, and evaporation is prevented from the tube, and the float cannot sink and pull down the lever from this cause. The convoluted tubes passing through an apartment are not represented in the drawing, as it can be easily conceived that the water which flows from the waste pipe could be conducted by tubes in any direction.

If we want to raise the temperature of the apartment, we have only to increase the heat of the bath: this is done by letting in a supply of hot water from the reservoir, and by then adjusting the weights of the lever so that it shall retain its horizontal position, while the bath will retain the increase of heat it has got. When the bath cools, the lever allows a fresh supply of hot water to flow in to raise it to its former state.

The heated water flows, of course, from a higher to a lower level, when the action of the lever permits it in this contrivance. The advantage of it is, that a boiler of an ordinary formation may be employed, and the bath in which the regulator is immersed, can serve for many domestic purposes, without interfering with the heat of the water discharged by the waste-pipe. This water, it is evident, can be available to heat an apartment, when it passes through tubes, though many matters may also be immersed in the bath at the same time.

In the Technological Repository, as above quoted, a detailed account, and a large copper plate, is given of the ingenious contrivances of M. Bonnemain, for regulating the heat of stoves, green-houses, &c. in France.

The boiler, in his plan, must however be entirely engaged in the process of heating the apartment, and is not avail-

able for other purposes at the same time; but, on the other hand, in his plan the heated water, after passing through the tubes, flows back again into the boiler in a continuous stream.

The action of the regulator which he employs, is founded on the principle of the unequal dilation of different metals by heat. Nothing expands so equably by heat as air or gas; therefore the regulator described in this paper, might, I think, be used with advantage as an adjunct to the contrivances of M. Bonnemain.

Let us see how this regulator might be used, without interfering with his other arrangements. The regulator, of the shape of the letter L, when made of copper, could have its bulb exposed to the radiant heat emanating from the side of the furnace of M. Bonnemain, and the gas contained in the bulb would expand or contract in proportion as the temperature of the furnace might rise or fall. The expansion and contraction of the gas in the bulb, could be easily made to open or shut the register door of the furnace, by means of the lever, one end of which might be connected with the float, and the other with the register door, by the intervention of rods or wires.

But to have the process carried on with great precision, it would be better to have the gas in the regulator influenced immediately by any change of temperature of the water circulating in the tubes.

The advantage of having the gas in the bulb influenced immediately by the temperature of the water, may be obtained in the following manner. Let the arrangement of the tubes, &c. for circulating the water, be the same as that of M. Bonnemain, with the exception, that in one place the tube swells out into a receptacle sufficiently large to contain the bulb of the regulator, and to allow the water from the boiler to flow freely by, in contact with the bulb. When the water cools, the gas in the bulb contracts, the float descends, and pulls down, by means of the wire, the end of a lever; the opposite end of the lever rises, and

opens the register door of the furnace, to admit a fresh supply of air. When the heat of the water rises, the gas expands, the float ascends, the lever returns to its former position, and shuts the register door.

If we employ the wire connected with the lever, without passing through a stuffing-box, it is evident that the gas in the bulb will have its bulk influenced by any change of atmospheric pressure through the open tube. Therefore, when a change is indicated by the barometer, the balanced lever will require to be adjusted. Gas, from expanding equably by heat, is admirably adapted for regulating temperature. I hope, that in this paper, I have shown how it may be used with advantage.

I have the honor to remain,

Your obedient, &c.

To T. GILL, *Esq.* J. M'SWEENY.

Remarks by the Editor.--We must own that we greatly fear that the application of the *air-thermometer*, in the manner proposed by our worthy correspondent, will fail in its intended effects, and therefore have thought it unnecessary to copy the drawings he has furnished us with.

At the same time we have to apprise him, that M. Puymaurin, in regulating the heat of the furnace lately employed in the Royal Mint at Paris, for extracting gelatine from bones, by M. D'Arcet's excellent process, has availed himself of M. Bonnemain's regulator for admitting air to the fire; but he has placed the leaden expanding and contracting tube horizontally in the boiler, near its bottom, with its front open end passing through the side of the boiler; so that no stuffing-box is now required for the iron rod or wire to pass through, from the inner end of the leaden tube, in order to act upon the levers which open or close the register-plate, to supply more or less air to the furnace, and thus this excellent regulator is now made applicable to the ordinary boilers.

LXXIV.—*On Cyoutchouc, or Indian Rubber.* By John K. Mitchell, *M. D., and* Charles Davis, *M. D.**

Philadelphia, Jan. 18, 1830.

We have received from the former of the above two gentlemen some account of his experiments on the distention and inflation of caoutchouc; he has also read a paper upon the subject before the American Philosophical Society; and several notices respecting them have likewise appeared in the daily journals. We shall probably hereafter lay some further details before our readers. The communication referred to contains the following information:—

Mode of making gum elastic into bags, sheets, &c.—Soak the gum elastic in sulphuric ether, until it becomes soft and almost inelastic, which, in good ether, will take from ten to twenty-four hours. Then, if it is a plate, cut it with a wet knife, or parallel knives, into such sections, sheets, or shapes, as may be desired; and suffer them to dry. Or, if a bag, or a bottle, apply a pipe, or a stop-cock to the neck, and inflate it with the mouth; rapidly, if the bag should expand equally; more slowly, and with occasional pauses, if unequally. By such means a bag may be made so thin as to become transparent, and light enough to ascend, when filled with hydrogen gas. By graduating the extent of inflation, sheet caoutchouc of any given thickness is produced. If for blow-pipes, or other purposes, for which it is desireable that the bags should possess contractibility, let them be inflated to the desired size; and, after an hour, let out the air. Ever afterwards they will suffer as great a degree of extension, and again contract. If permanent sheets are wanted, the inflated bags are to be hung up until dry, after which no sensible contraction will ensue.

Bags softened by ether may be readily stretched by hand, over lasts, hat-blocks, or other moulds, so as to assume the

* From the Journal of the Franklin Institute.

these moulds, and suffered to dry; in about ten minutes a second coating was applied; it required about thirty coats to form a boot of the proper thickness. When the boots and gloves were finished, they were removed from the moulds, by turning them over at the tops, and stripping them off, as a glove is drawn off from the arm. Gloves and stockings, made of cotton yarn, were also drawn upon the moulds, and them immersed in vessels containing the fluid gum. When taken out, and exposed to the air, an envelope was formed upon every fibre of the cotton; so that, for gloves, or stockings, no additional coating was necessary. Pieces of strong canvass, coated with the gum, were formed into soles, heels, and straps; these, when dry, were moistened on the surface with the recent juice, and applied to the stockings, to which they became firmly agglutinated; and thus boots were formed, which present a very neat appearance. By spreading the liquid on the surface of nankeen, Dr. Howison formed a cloth, which was very flexible, and perfectly impervious to water. He recommends this cloth as a suitable material for garments; no sewing would be required; the edges of the different pieces being placed in contact, and wetted with the recent juice, would adhere, and the article would be ready for use*.

From these facts, it is obvious, that if caoutchouc could be procured in large quantities in a fluid state, it might be applied to many important purposes. It, therefore, becomes an object to devise some means by which the solid gum, as it is found in commerce, could be wrought into the different forms best adapted to various uses. From a variety of experiments made by different individuals, the following results have been obtained:—

When heated in close vessels, to a high temperature, caoutchouc melts into a black viscid substance resembling tar, which does not concrete on cooling. When this substance is incorporated with oil of turpentine it forms a tough

* Philosophical Magazine, Vol. 6.

varnish, which has been used by Mr. Jacob Perkins, as advised by A. Aikin, Esq., Secretary to the Society for the encouragment of Arts in the Adelphi, to defend the surfaces of his steel dies, plates, &c., used in his excellent process of siderography, from the action of the air and moisture. The varnish may be removed by means of a brush, charged with warm oil of turpentine.

Boiling water softens caoutchouc, but does not dissolve it; two pieces, which have been boiled for a long time, when strongly pressed together, form a permanent adhesion with each other. When softened in this manner, it may be drawn out into thin lamina, resembling gold-beater's skin. An artist, Mr. Matthias More, conceived the idea of substituting transparent slips of caoutchouc for the glass slides on which the figures are painted, for magic lanterns. He purposed to paint, or print, the figures on a long slip of caoutchouc; this was to be wound on and off a cylindar, thus bringing the figures successively before the lens. By soaking the caoutchouc for many hours in warm water, he succeeded in stretching it to a very great extent, and in rendering it very thin and transparent. Bottles of this substance were inflated by means of a pair of bellows—the bags thus formed, when filled with hydrogen gas, ascended into the atmosphere*.

Gum elastic bags may be dilated, without previously softening them, by forcing in air with a condensing-pump.

When caoutchouc is boiled in the expressed vegetable oils, in wax, butter, or animal oil, it is dissolved; and, combining with these substances, forms viscid inelastic compounds. Ether, naphtha, and cajepur oil, appear to be the only solvents from which it can be separated unchanged. When the ethereal solution is poured upon water, it spreads equally over the surface, the ether rapidly evaporates, leaving a thin film of caoutchouc, which retains all its characteristic properties. The rapidity with which the ether evaporates, renders it very difficult to apply

* Philosophical Magazine, Vol. VI., page 59.

this solution to any practical uses; this, together with the expensiveness of the solvent, has hitherto rendered its applications extremely limited.

"In order to form tubes of caoutchouc, the best method is to cut a bottle of this substance into a long slip (spirally), and soak it for half an hour or an hour in ether; by this means it will become soft and tenacious, and if wound dexterously on a greased mould, bringing the edges into contact with each other, at every turn, and giving the whole a moderate and equal pressure, by binding it with a tape wound in the same direction as the caoutchouc, a very effectual union will be produced*".

Dr. Roxburg, to whom we are indebted for a botanical description of the East Indian vine, from which the caoutchouc is obtained, dissolved this substance in cajeput oil. When alcohol is added to this solution, the caoutchouc is separated from the oil, and floats upon the surface, in a semi-fluid state; when exposed to the air it becomes firm, and retains its elasticity perfectly.

"Mr. T. Hancock has succeeded by a process, which he has not published, in working caoutchouc with great facility and readiness. It is made into large cakes, and being cut with a wet knife into leaves or sheets, about one-eighth or one-tenth of an inch in thickness, can then be applied to almost any purpose for which the properties of the material renders it fit. The caoutchouc thus prepared is more flexible and adhesive than that which is found in the shops, and is worked with singular facility. Recent sections, made with a sharp knife or scissars, when brought together and pressed, adhere so firmly, as to resist rupture as strongly as at any other part; so that if two sheets be laid together, and cut round, the mere act of cutting joins the edges together; and a little pressure on them makes a perfect bag of one piece of substance. The adhesion, in those parts where it is not required, is entirely prevented by rubbing them with a little flour. Bags made of this

* Rees's Cyclopædia, Art. Caoutchouc.

substance have been expanded by having air forced into them, until the caoutchouc was quite transparent; and when expanded by hydrogen gas, they were so light, as to form balloons with considerable ascending power; but the hydrogin gas gradually escaped, perhaps through the pores of this thin film of caoutchouc*."

Dr. John K. Mitchell has lately formed large balloons of caoutchouc by softening the bottles in ether, and afterwards inflating them; it was one of these balloons, filled with hydrogen gas, which rose into the air, and fell, as above-mentioned, at the distance of 130 miles from the place of its ascension.

The elasticity and tenacity of caoutchouc, its power of resisting the action of most chemical agents, and the recent improvements in working it, promise to render its applications in the arts much more extensive than they have hitherto been. The process for softening the caoutchouc, is, by leaving the bottle for ten or twelve hours in common ether; and then to blow it out to the desired thinness, by fastening into the neck a tube, with a stop-cock.

LXXV.—*On Winding-up Clocks, by taking advantage of various Natural Changes, and Artificial Movements*†.

A PATENT has been taken out by a Mr. Richard Ward, of Waterbury, New Haven county, Connecticut, on Nov. 5th last, for the application of air to the above purpose. Air, like other bodies, is expanded by heat, and contracted by cold; it is proposed to use the expansion and contraction of this fluid, by natural changes of temperature, to keep a clock wound up.

An air-chest, or reservoir, of the capacity of four or five gallons, it is estimated by the patentee, will be sufficient

* Quarterly Journal, Vol. XVII.

† From the Journal of the Franklin Institute, with additions, by the EDITOR.

for a time-piece with a striking movement. A tube is to pass from this air-chest into a small gasometer, constructed with three concentric cylinders, precisely like those used for holding gases by the chemist. When the air expands in the chest, it is forced through the tube, and raises the middle cylinder of the gasometer; and when it contracts, that cylinder consequently falls. This cylinder is so suspended, that a cord or cat-gut, which passes over a pulley, turns a drum or barrel, and winds up the clock, whether ascending or descending. The particular modes of effecting this, described by the patentee, we shall not at present detail; those conversant with machinery will be at no loss in conceiving how this may be done.

That a delicately made time-piece may be wound up, by the expansion and contraction of fluids or solids, from natural changes of temperature, is an admitted fact. We have before made the following remarks upon the subject of the application of some of the moving objects in nature: "Some of these may be employed to keep clocks and other engines wound up, so that their action shall be continued. The contractions and expansions of a long bar of metal, from changes of temperature: the perpetual currents of rivers; the flux and reflux of the tide; regular and irregular winds, and draughts or currents of air; the hygrometric changes in certain substances, are of the kind intended; the employment of some of them is familiar, and the possibility of using the whole of them, as well of some others which are not enumerated, will be evident to most of our readers."

On the employment of frequently recurring artificial movements, for similar purposes. By the EDITOR.

We well remember, many years since, a clock, in Merlin's celebrated Mechanical Museum, near Hanover-square, which was wound up by the movements of a door in the house; and which was necessarily opened and shut many times a day. Our friend, Mr. J. J. Hawkins, also proposed,

long since, to avail himself of the vast quantity of power, and which might be usefully employed to work machinery, to be obtained from the constant passage backwards and forwards, of a number of persons over the yielding or springing-boards of a cellar-door, in any of the great thoroughfares or alleys in this metropolis; and which downward pressure might easily be transferred to work machinery. We also recollect Mr. James Jones, Engineer, whose improvements in screw-stocks and taps, we have lately given, employing the motion of a door in his father's premises, which was continually opened and shut throughout the day, to work a pump in the lower story or cellar of the house, which raised the water from the sink to the surface of the ground, whence it could easily run off, as there were no sewers to drain it below.

These suggestions may, no doubt, occasion our readers to avail themselves of many other sources of power, readily attainable ; but of which, for want of being reminded thereof, they never yet profited.

We find a patent is lately obtained, by a Mr. Henry H. Western, of New York, for a tide-power, to work machinery, by the rise and fall of the tides on the sea-coasts ; he proposes to employ vessels or floats of great weight and buoyancy, so that, in the instance of the fall of the tide, by their weight, or their weights contained in them ; and in the rise of the floats, by their floating, they may apply both ways a force proportionate to their weight and magnitude; and which, being connected to a lever, or beam, may be applied to draining or putting in operation machinery, and thereby saving animal, steam or other powers, and possessing the very important advantage of contiguity to the marts of the manufactured articles.

The invention may be put in use by the affixing of a condemned or other hulk of a ship, of the required size. Or floats, with proportionate weights in them, properly affixed in one of the usual slips, or in any tide-water ; and the beam or lever extended into a building projecting over

it, or by the side of it, or on the side of streets fronting on the slips, and in other situations contiguous to the tide-water, the extent of the power to be regulated by the size and weight of the float.

Dr. Thomas P. Jones, the Editor of the Journal of the Franklin Institute, remarks, that "the power to be obtained from the foregoing plan, supposing such an arrangement to be made as shall place it all under command, may readily be computed, its elements being the weight which rises and falls, and the distance of this rise and fall with every tide." This power the patentee claims to apply to machinery, 'or any other required use.' It has been repeatedly applied to use in raising sunken vessels, and in removing rocks and other obstructions from the bottoms of rivers. If, therefore, the claim is intended to be made abstractedly, it seems to us that it cannot be sustained."

LXXVI.—*On the extraordinary effects of an Earthquake at Lima, in* 1828. *By Capt.* T. M. BAGNOLD*.

Knightsbridge, June 18, 1829.

"HAVING experienced, during my residence at Coquimbo, on the coast of Chili, no less than sixty-one smart shocks of earthquakes in twelve months, without taking minor ones into consideration, I was induced to obtain, from an officer of H. M. S. Volage, the particulars of the destructive visitation which occurred at Lima in 1828.

"On the 30th of March H. M. S. Volage was lying moored with two chain cables in the bay of Calloa; the weather was remarkably fine and clear, when, at half-past seven o'clock, a light cloud passed over the ship; at which moment the noise usually attendant on earthquakes in that country, resembling heavy distant thunder, was heard; the ship was violently agitated, and, to use the words of my informant, 'felt as if placed on trucks, and dragged rapidly over a pavement of loose stones.' The

* From the Quarterly Journal of Science.

water around 'hissed as if hot iron was immersed in it;' immense quantities of air-bubbles rose to the surface, the gas from which was offensive, resembling, to use my friend's phraseology again, 'rotten pond-mud.' Numbers of fish came up dead alongside; the sea, before calm and clear, was now strongly agitated and turbid, and the ship rolled about two streaks, say fourteen inches, each way. A cry of 'there goes the town,' called my friend's attention towards it: a cloud of dust, raised by the agitation of the earth and the fall of the houses, covered the town from view, whilst the tower of the garrison chapel, the only object visible above the dust, rocked for a few seconds, and then fell through the roof; and, from the high perpendicular rock at the north end of the island of St. Lorenzo, a slab, supposed thirty feet thick, separated from the top to the bottom of the cliff, and fell with a tremendous noise into the sea. The wharf or pier was cracked three parts across, showing a chasm of eighteen inches wide; the chronometers on shore, except those in the pocket, and most of the clocks, stopped, whilst the rates of chronometers on board were in many instances altered. A great number of lives were lost, amongst which were four priests, killed in the churches, one of them by the falling of an image, at whose base he was at prayer.

"The Volage's chain cables were lying on a soft muddy bottom, in thirty-six feet water; and, on heaving up the best bower anchor to examine it, the cable thereof was found to have been strongly acted on, at thirteen fathoms from the anchor, and twenty-five from the ship. On washing the mud from it, the links, which are made of the best bolt or cylinder wrought-iron, about two inches in diameter, appeared to have undergone *partial fusion* for a considerable extent. The metal seemed run out in grooves of three or four inches long, and three-eighths of an inch diameter, and had formed (in some cases at the ends of these grooves, and in others at the middle of them) small

spherical lumps or nodules, which, upon scrubbing the cable to cleanse it, fell on the deck. The other cable was not injured, nor did my friend hear of any similar occurrence amongst the numerous vessels then lying in the bay. The part of the chain so injured was condemned, on the vessel's being paid off at Portsmouth, and is now in the sail-field of the dock-yard, and I should think a link of it would be worth preserving in the museums of the different scientific bodies*.

"That the phenomena of earthquakes are produced by volcanic explosions, there can be little doubt, and that they are frequently accompanied by powerful electric action, has long been known. To which of these causes are we to look for the powerful effects here described?"

LXXVII.—*Observations on the Paddle-Wheels now used in propelling Steam Vessels, and on those recently invented and patented by* Jacob Perkins, *Esq. Engineer.*

Since the application of steam to the purposes of navigation, no description of machinery, except the steam-engine itself, has occupied so generally the time and attention of mechanics as the paddle-wheel. Inventions, endless in variety, have been patented for propelling steam-vessels: till lately, however, none have been found so efficient, durable, and economical, as the common wheel, notwithstanding its waste of power is very considerable.

When the dip of the common wheel is not more than one-tenth of its diameter, the waste is erroneously supposed to be inconsiderable; but when it exceeds that proportion, the loss of power is confessedly in geometrical progression, it being found that if the wheel be immersed to half its diameter, the strain on the engine becomes so

* Our readers will find a notice of this very singular effect, as described to us by a friend who saw it at Portsmouth, in vol. V. page 272.—Editor.

great as to leave very little of its force applicable to the propulsion of the boat.

Of course sea-going steamers are, from the irregularity of the ocean's surface, more exposed to this injurious influence than vessels navigating rivers or quiet waters, where the dip of the wheel can be regulated.

It is obvious that the common paddle, when at the lowest dip, where it should have the greatest power, moves in water already disturbed by the preceding paddle, and it is evident that after the paddle has passed the lowest dip, it is not promoting the progress of the vessel, as it would do if it were acting in undisturbed water.

To obviate some of the difficulties above stated, an eminent individual, Mr. Oldham, of Dublin, has, in common with many others, taken great pains and incurred considerable expense. He constructed a wheel, the paddles of which enter the water edgeways, and by machinery attached to them, gradually change their position, until, on their successively arriving at the lowest extremity of the wheel's rotation, they present a face at right angles with the keel, and then gradually revolving, leave the water edgeways. But the complexity, increased friction, liability to derangement, weight and expense of this wheel, were found more than to counterbalance its theoretical superiority.

Simplicity, durability, lightness, and cheapness, are requisites not to be dispensed with in the construction of paddle-wheels. If with these essentials a wheel can be constructed to work with undiminished action, at a dip ordinarily of one-third, and occasionally of one-half its diameter, without incurring a greater consumption of steam power than attends the common wheel, when used in still waters, then a remedy will be found for the great loss now experienced in sea-going vessels. Such a wheel has lately been invented by Mr. Jacob Perkins.

Those who have witnessed the Chinese method of sculling, must be strongly impressed with the superiority of

that over the European application of the oar. The action of Mr. Perkins's wheel is not unlike that of the Chinese scull; in fact, the only difference is, that the motion of the scull is reciprocating, that of the paddle-wheel in question rotatory; the rotatory motion being clearly preferable, inasmuch as the frequent change of motion in the scull is so much waste of power.

Comparative experiments with the common, and with the newly invented, wheel, alternately used in the same boat, have shown, that even at a shallow dip, the most appropriate to the common wheel, there is a very important gain with the wheel of Perkins. But when the wheels are each of them immersed to one-third of their diameter (perhaps an average dip for sea-going vessels), the advantage attending this newly invented wheel is scarcely credible!

Facts are stubborn things, opposed as they may be to the theories of men of acknowledged ability. It has been asserted by certain eminent engineers, that the common wheel admits of but little improvement. If it cannot be demonstrated that much power is lost by the common wheel, then would those engineers be borne out in their assertion. But recent experiments, made in England and America, prove the loss of power with the common wheel to be very much greater than had hitherto been imagined. If the loss were trifling, could a single horse on a towing-path do the work of a six-horse engine in the boat? Could two horses attached to the hawser of a boat, moved by a twenty-five horse power engine, neutralize the power of the engine, stay the progress of the boat, and occasionally give her stern away? These facts, however, are well authenticated!

Engineers, who believe in the perfection of propelling machinery on the old plan, exultingly reply to these facts, by making abstract inquiries. such as, whether a vessel can move as fast as the periphery of the wheel by which she is propelled? Whether, if a boat move four-fifths as

fast as the periphery of the wheel, it is not considered fair speed? and then come to the conclusion, that the whole loss of power cannot exceed one-fifth, and that allowing for friction, it is absurd to expect to save much of that small proportion by any improvement. That this conclusion is premature, the following remarks are intended to prove.

Let it be supposed that a paddle wheel can be made of such power, and to have such hold on the water as to move only one-hundredth part faster at its periphery than the vessel it propels, the difference in such case between the relative velocity of the wheel and the vessel, would be as ninety-nine to one hundred. It is true the magnitude of the wheel would require steam power in proportion, and then the remedy would be as bad as the disease, but the case is practicable. To suppose, therefore, that the loss of power is only as the relative movement of the wheel and of the boat, is as absurd as it would be to assert, that inasmuch as the carriage wheel and its body move with equal velocity, it matters not what load the carriage contains. In the one case the speed or draught of the horses must be increased, so in the other must the steam power.

We will consider the subject, however, in a more tangible shape. There are four kinds of water-wheels, of which the undershot assimilates more to the paddle-wheel than the others; and the undershot wheel, it is acknowledged, loses two-thirds of its power, that is to say, if three pounds of water fall one foot on an undershot wheel, it will not communicate impetus sufficient to raise more than one pound to the height of the fall. Let us examine these data in three points of view with relation to the paddle-wheel.

1st. The undershot wheel is propelled by water descending on it.

2ndly. The water so falling is so directed as to strike the float-boards at right angles with their surface.

3dly. Although the power is communicated by water

moving at a quicker rate than the wheel, yet so soon as it has communicated a portion of its impetus to the wheel, that quantity of water left on the float-boards, and hurried round with the wheel, is dead weight, and serves only to impede the wheel's velocity, and so to diminish its power.

In all these particulars, the disadvantages attending the common paddle-wheel are greater than those above described.

1st. The water cannot descend upon a wheel revolving on a plane of water.

2ndly. The paddles do not strike the water at right angles with their surface, yet the impetus given by the first paddle is the principal power, inasmuch as it is exerted on undisturbed water, all the others moving in water previously disturbed.

3dly. The inert body of water between the paddles, carried round by the wheel, must be greater than that carried round by the undershot wheel. And, above all, the back-water is far more considerable with the paddles, than with the undershot wheel.

Now if the loss of power with the undershot wheel is allowed to be two-thirds, and it has been demonstrated that the loss by the paddle-wheel is greater than with the undershot, efforts to improve the paddle-wheel will be less open to be characterised as visionary and unprofitable.

Mr. Perkins's improvements remedy, in a great degree, the losses of the common wheel, whether by indirect action or by back-water. The paddles are made to enter and leave the water edgeways; when at the lowest rotation of the wheel, their action is at right angles with the keel; each paddle enters into, and moves in, water undisturbed by any preceding paddle; and thus every paddle immersed is doing service, though in different degrees, at the same moment.

The new paddles show the greatest proportionate advantage when one-third and upwards of their diameter is immersed. This degree of immersion would ordinarily

amount to from seven to eight feet, instead of two, the advantageous dip for the common paddle. The resistance of water being so much greater at the depth of eight feet than it is at two, too much importance cannot be attached to this material distinction between the two modes of propelling—Perkins's paddle being made more in the shape of an oar blade than of a float-board.

As Perkins's paddles do not strike the surface of the water with their flat sides, on entering it, the constant tremulous motion, experienced in steam-boats, will be obviated. So violent is the concussion, in a heavy sea, with the common paddle, or if the wheel be much immersed, that the destruction of the paddle, and even of the shaft, or parts of the connecting gear, are not unfrequent occurrences.

LXXVIII—*On different kinds of Bread**.

We distinguish three species of bread: in the first kind, termed bread made without leaven, we knead the flour up with water, with or without the addition of eggs, butter, sugar, &c., and then expose the paste either to the action of heat, or of the air, until it becomes hard and solid. This bread is never spongy.

In the second kind, named leavened bread, the flour, after being mixed with water, and reduced to a liquid pap, is left to itself for several hours, in order that the panary fermentation may take place throughout the mass; that is to say, that the saccharine matter which exists in the farina may be changed into alcohol and carbonic acid; which, finally, by their expansion, when aided by the action of heat, render the bread light and spongy. More frequently, however, instead of leaving the mass to ferment of its own accord, we facilitate the fermentation by means of certain substances termed leavens or ferments, which change the whole mass more speedily.

* From *l'Industriel Belge.*

In the third species of bread, we cause a sort of artificial fermentation to take place, by adding to the paste certain substances, which, by the assistance of heat, suffer gas to escape continually, and form bubbles, or those cells which change the nature of the paste, and give to the bread that spongy appearance and lightness, which, in the other case, resulted from the fermentation of the mass. This bread has not received any name in particular, and the bakers do not prepare it unless expressly desired to do so.

The various farinas differ in the quantities of bread which they produce. For household bread, they prefer that which absorbs the least water. This, however, is not that preferred by the bakers, and the reason is clear. The methods of kneading, give to the bread different qualities; and they employ two modes. In the first method, both in France and in England, they introduce a great quantity of air into the paste. This operation produces an acid, and also a portion of sugar. In the second method, they are contented with pressing the mass; and, in this case, it appears that no sugar is formed. It is by this mode that they prepare sea-biscuits.

As the fermentation of the flour proceeds slowly, so it becomes indispensable to add something to quicken it; this effect is obtained by means of leaven. It is not, however, necessary to prepare the leaven every time the bread is made; it is sufficient to lay by a little of the paste remaining from the last baking, and which will ensure the acid fermentation; this may be placed in a bag of flour, or, otherwise, we may daily add to it a certain new quantity of flour, and sufficient water, to preserve it of the same consistence; or, which is still better, we may dry this paste, and then it may be preserved for any length of time. In the north of Europe, they use as ferments the scum which forms during the fermentation of beer, and which they term yeast. The effect of this is more speedy than that of the leaven. Or we can easily procure it, by boiling three and a half pounds of flour, in three pints of water, for ten mi-

nutes, of which we pour off two pints, and keep it in a warm place. Fermentation will commence about thirty hours afterwards. At this time, we pour into it four pints of a similar decoction of malt, and when the fermentation has again commenced, we add another similar quantity, and so proceed. In France we comprehend under the term yeast, not only the scum, but also the dregs, of beer, and which equally serves the purpose. At Edinburgh, and in Hungary and Sweden, they employ diffeient processes to procure yeast; but all of them depend upon the principles above described. When the baker has not a sufficient quantity of light paste for his baking, he may supply the want of it by mixing the sub-carbonate of ammonia with his flour and water; and after well kneading it, place it in the oven.

Ovens are usually constructed either with bricks or stones. The latter retain the warmth best, and are also more easy to heat. In London, the oven is kept hot all day; and they preserve the heat by frequently supplying a small fire-place, which is constructed in the side of the oven, with fresh fuel; a circular flue passes under and around the oven, from this fire-place, in its way to the chimney. The experiments of M. Loth have shown the advantage of having a grate placed near the bottom of the oven, to keep up the heat. The brick furnace should be kept in constant use; as, if it be suffered to become cold, the supply of the combustible will necessarily be much greater, nor will the baking be so perfect.

We know that the bread has been well made, firstly, if on cutting the loaf through from top to bottom, it presents on the cut surfaces a quantity of cells, which continually increase in their diameters from bottom to top, but, nevertheless, without being too large. Secondly, when the middle of the loaf is as dry as the parts near the crust, and does not crumble too much on cutting it; a proof that it does not retain too much water. Fifteen pounds of good

wheaten flour ought not to absorb more than ten pounds of water, to convert it into a paste; and this quantity, when well baked, ought to yield more than twenty pounds of bread.

London bread.—The method most followed to make the fermented bread is as follows.

They dissolve in thirty-six pounds of warm water, from four to six pounds of salt, at the temperature of eighty-four degrees of Fahrenheit, and then add three pints of yeast: on the other hand, they make a hole in the midst of a heap of two hundred and eighty pounds of sifted flour; and with the solution of salt, and sufficient yeast for the flour, they make a paste sufficiently thick, and which they term a quarter sponge; they then again cover it with more flour, and close the kneading trough with a piece of flannel. Three hours afterwards, they add three hundred and sixty pounds of boiling water to it, and knead up the mass with a new quantity of flour; this they term half sponge; five hours afterwards, they again add one hundred and eight pounds of hot water, and work it with the remainder of the flour, for an hour at least; they then cut it into bits, again cover it with flour, and leave it at rest in a corner of the trough. Four hours afterwards, they knead it for half an hour, and then form it into loaves, which they afterwards place in the oven. They judge when the oven is sufficiently hot, by throwing a pinch of flour into it, and which ought to become black instantly, but without taking fire; they place the loaves so near to each other in the oven, that when they rise, they press each other, and take the form of cubes. They leave them two hours and a half in the oven, and when they withdraw them, they take care to cover them, to prevent them as much as possible from losing their weight. This loss, from the baking, amounts to a ninth part of the total weight, and yet the loaves nevertheless become three times as large as when put into the oven. In London, they put half a pound of alum

instead of the same quantity of salt, into the bread, as a seasoning. In the poorer parts of the country, they use equal parts of salt and alum.

Household bread.—There are but few bakers who make this bread, it is ordinarily made in those families who bake their own bread. As the brown farina retains a much greater quantity of water than flour does, so this bread remains fresh for a longer time than the white bread, but is apt to crumble. As it is not in general well kneaded, so it has a particular taste, which, although a little sour, yet it pleases many palates. It has likewise all the imperfections of being the first baking in an oven, which had become cold; and, therefore, they prefer to use sheet-iron ovens, and to substitute cast-iron or sheet-iron in place of the vault of bricks; and which iron ovens also serve to bake other alimentary articles. Holmes's oven is of this kind, and derives its heat from a mass of cast-iron which projects from its side into the fire-place, and thus no flues are required*.

They endeavour to increase the weight of bread in various modes; but, in general, at the expense of its nutritive qualities. Nevertheless they may employ gelatine to advantage, according to M. D'Arcet's process.

Sea biscuits.—To make the best biscuits, or the *American crackers*, they take a good thin paste, and roll and double it many times, as if for puff-paste. The common sea-biscuits differ from the preceding, in not being made with so many doublings. They make a thick paste, without leaven or salt, and in proportion as it extends beyond the feet, with which they knead it, they cut off the borders and throw them into the middle, and knead them anew. They thus obtain a biscuit, which breaks in plates. These are baked in a very low oven, which resembles a muffle.

Spiced bread. (Gingerbread).—To make this, they dis-

* The Editor possesses one of Holmes's ovens, and can testify to its great convenience and utility. He was rewarded by the Society of Arts, many years since, for this valuable invention.

solve half an ounce of potash, and a little alum, in hot water; they then melt in it an ounce of butter, and knead it up with quick strokes, together with three quarters of a pound of treacle, and an ounce of mixed spices, of which the composition is variable; but for the most part consists of ginger, canella, nutmegs, and the four spices. Caraway-seeds, aniseseeds, raisins of Corinth, almonds, and other confectionary articles, are also sometimes added. We may also omit the alum, and replace the potash, by the carbonate of magnesia, which, by the strength of a small quantity of it, enables us to compound it as follows: viz., Two pounds of flour, half an ounce of magnesia, one pound and a-half of treacle, two ounces of butter, and the necessary quantity of water to knead it, holding in solution a quarter of an ounce of tartaric acid, form a paste which will rise in half an hour. In France the spiced bread is made with honey, and rye meal, without any butter or water.

French bread.—The bakers in France commence their operations at five o'clock in the morning, by mixing five pints of water, and three pounds of leaven, reserved from the last baking, and as much flour as will make a paste, weighing seventeen pounds. Ten hours afterwards they add ten or eleven pints more water, and sufficient flour to make a paste of forty pounds weight; two hours afterwards, twenty-four pints more water, and flour enough to make a paste of the weight of one hundred and twenty pounds. From this paste they cut off a portion of three pounds in weight, to serve for the leaven of the next day's baking. Then, four hours afterwards, they make a new addition of one hundred pounds of flour, and from seventy to eighty pints of water, and which will yield a mass of about three hundred pounds weight. They then begin to beat the paste, and when it is well kneaded, they separate about eighty pounds of it, which is to serve as the leaven for the next baking. This paste is so fluid, that the loaves cannot preserve their form before they have been exposed to the heat of the oven. For the second baking, after hav-

ing mixed the quantity of flour necessary, by kneading it, they add the paste reserved from the former baking, and, when the mass is finished, they cut off a part weighing eighty pounds, and thus they proceed a third time, a fourth, and so on, until they have made twelve bakings. They thus continue to work for several days together, only they modify it after every fourth baking, by adding what they term *a young leaven* to the paste which each baking had impaired or weakened. If they would introduce into the paste either salt or yeast; they thin it in a proper manner with water, which contains yeast or salt in solution. They also use yeast for the *soft bread.* A quarter of a pound of the yeast from beer is equal to eight pounds of the paste leaven; so that four ounces of yeast are equivalent to twenty pounds of the paste. The paste in which they have mixed the yeast, must not, however, be mixed with that containing leaven.

In France, they estimate the consumption of bread, including that used with soups, at two pounds and a quarter per person; whilst, in England, it is not quite thirteen ounces.

French sea-biscuits.—To one hundred pounds of flour they add ten pounds of leaven, but older than that which is used for making bread, and with water, form it into a thin mass, which is well beaten. They finally cut it into bits, of a certain weight, flatten it with a rolling-pin, and prick it full of holes. It is baked for two hours.

German bread.—This is named *semmel,* and is made with fine flour and yeast; and they always make the paste a few hours before they bake it. The large semmels weigh about half a pound each; but the best not above two ounces; they are of an oblong form, and sometimes adhere in rows of five or six dozens. But, with the exception of these, all the bread prepared in Germany is made with rye meal and wheaten flour, of which the proportions vary. Their ovens are of an oval shape, and the vault is sufficiently elevated. In Russia their ovens are composed of plates of cast-iron.

LXXIX.—*On the manufacture of Red, Green, Yellow, and other Enamel Colours**.

Red.—This is a primitive colour, that is to say, it is not formed by a mixture of other colours; it is generally obtained from iron. There are plenty of processes for making it; some consist in calcining the sulphate of iron, others in oxidizing native iron, by the aid of a strong heat and the contact of the atmospheric air. But the following is the manner of procuring the most beautiful red.

We must procure a quantity of steel, the best and finest which can possibly be had; the old blades of English razors are very good for this purpose. These must be broken into small pieces, and be introduced into a matrass containing sulphuric acid diluted with water. The solution may be made in the cold, but much better and quicker by the aid of heat. When it is effected, the solution must be poured into a porcelain bason, and be evaporated on a sand-bath, until the liquid has attained a certain degree of concentration; it must then be exposed to the open air, when crystals of sulphate of iron will be formed. When these have attained a proper size they must be taken out of the mother waters, and be placed upon a leaf of paper to be washed.

After the sulphate has been well purified, it must be dissolved in about three times its weight of distilled water, be filtered through paper, and evaporated a second time. It will then form, on cooling, crystals of the sulphate of a beautiful emerald green colour, and very transparent. After these have also been well washed and dried, they must be enclosed in a wide-mouthed bottle, with a ground stopple to it.

When we would prepare the red colour, we take one part by weight of the sulphate, and a quarter of a part of sulphate of alumine (alum), and grossly powder them, in order the better to mix the two salts; on the other hand,

* From the *Dictionnaire Technologique.*

we make a charcoal fire in a calcining furnace, and when it is of a good glowing heat, we place a plate of thin sheet-iron upon the coals, on which we have previously laid the two powdered sulphates. The aqueous fusion of the two salts takes place at the same time, but the mixture is at first white, and then reddens: we should therefore take great care not to make the fire too strong, lest we cause this red tint to fade. Finally, when we perceive that the colour is uniform throughout, we remove the plate from off the burning coals, and leave it to cool, and we may distinctly perceive that the more it approaches to the temperature of the atmosphere, the finer the red colour is developed.

Nevertheless, as we may always find in the calcined mass, certain parts of the oxide of iron where the red is of a more agreeable tint than in other parts, so we may select them. We deposit these selected pieces upon a glass slab, moisten them with distilled water, and grind them with a glass muller until we have reduced them to a very fine powder. When this is effected, we remove the colour with a pallete-knife, and place it in a porcelain vessel, when we wash it repeatedly with hot water, decanting the water each time; finally, we dry the residuum in a gentle heat.

In order to make known the reason for adding a fourth part of the sulphate of alumine to one part of the sulphate of iron, we must say that it is not because the colour becomes thereby finer and more intense; on the contrary, the alumine, by the white tint natural to it, tends to deaden the clear red which the iron manifests; but as that colour is extremely fugacious, the alumine by its refractory property, gives it a certain fixity which it would not otherwise possess; so that although this last substance predominates in the composition, yet the red colour is more fixed, although less intense. But we must not proceed beyond the due limits in this respect.

This red is greatly employed in vitrefiable painting;

it is used in imitating many flowers and fruits: it also forms entire draperies; it likewise enters into the tints destined to imitate the carnation, such as in certain parts of the lips, the corners of the eyes, &c.

The alkaline fluxes are not proper to be mixed with this red colour; the metallic fluxes are much better. This colour is one of those which spread readily under the pencil, and as it receives a large quantity of flux, so it is greatly used upon glass, enamel, and porcelain.

Of flesh-coloured enamel.—This colour, whose name is sufficient to demonstrate that it is very useful in this kind of painting, is also made with the sulphate of iron; but instead of only using one-fourth of a part of the sulphate of alumine, as in the case of making the red colour, we mix two, three, and even sometimes four parts of it; so that, as we know that the alumine is a white substance, the red becomes paler accordingly in notable proportions, and we thus obtain what are termed *flesh colours.* We here also perceive, that in virtue of the refractory quality of the alumine, we are obliged to introduce in the flesh colours a greater quantity of the above-mentioned fluxes; nevertheless experience has pointed out in a peremptory manner the theory for the best mixtures.

Green-coloured enamels.—These colours may be obtained from two metals, copper and chrome. The following is the manner of procuring it from the first of these metals.

We choose the finest rose copper which can be had, make it very thin, and cut it into small bits, which we dissolve in two or three times their weight of nitric acid, diluted with water. We must take care to introduce the metal a little at a time, in order to prevent a too great effervescence taking place, and lest we should risk the sudden loss of the oxigen in the acid. We add the metal as we see the action is terminated, and thus continue until a perfect saturation is obtained; finally, we place a crucible in a wind-furnace, and heat the crucible by placing burning charcoal

around it; we then pour into it about a fourth part of the contents of the solution of copper. When the liquid receives the impression of the fire, it swells and mounts towards the upper part of the crucible. If it threatens to escape, we must direct the wind from a pair of hand-bellows into the midst of it. This precaution hinders the loss of the liquid, and it instantly falls to the bottom of the crucible.

When the evaporation of the quantity first poured in is completed, we add another portion of the solution, always taking care to put in but a little at a time, for the reason above assigned. We thus continue the process until the whole quantity is poured in, when we cover the crucible, and carry the calcination to a red heat. At the end of a quarter of an hour's firing, we take out the crucible, and let it cool. When we can take it in the hand, with a steel knife, whose point is a little rounded, we remove the oxide of copper, which appears in the form of a very black powder, and in a state of extreme division, unless the fire has been too violent, in which case the oxide will be of a grey colour, and its molecules become agglutinated, and attached to the interior of the crucible, so as to make it difficult to remove them. This circumstance is an inconvenience which it is better to avoid by employing a moderate fire.

Potash and soda also precipitate copper from the nitric solution of it; but then the precipitate is of a bluish green colour: by calcination it becomes black. We may employ either of these two processes, but must observe that the first is that constantly used.

The oxide of copper affords a fine green colour when it is vitrefied with fluxes; but it is a little difficult to use with the pencil. Nevertheless this colour is indispensable, it furnishes those tints which are peculiar to it, and which the oxide of chrome, of which we shall next speak, is incapable of affording.

Another green colour, produced by the oxide of chrome. — This oxide is obtained by the decomposition of a stone, which is named chromate of iron. This stone is of a bluish grey colour, and often black. The following is the manner of treating it, in order to procure the green oxide of chrome.

We pulverize the stone in an iron mortar, and pass the powder through a very fine sieve; it is then mixed with a little less than its own weight of the nitrate of potash, also pulverized. The mixture being intimately made, we fill a Hessian crucible two-thirds with it, and place it in a wind-furnace; we then cover the crucible, and heat it. We should observe that we must take care to apply the fire by degrees. As the matter begins to become red-hot, we perceive a movement to take place throughout the whole mass; the nitrate of potash is decomposed, and there escapes from the mixture, between the cover and the upper edges of the crucible, a great quantity of azote, in the gaseous state. The residuum in the crucible consists of the chromate of potash, alumine, silex, and the oxide of iron.

The operation may last from half an hour to three-quarters of an hour, with a continued fire: at the end of this time the crucible is withdrawn from the furnace, and left to cool; it is then broken, and its contents pulverized. This powder is then mixed with four or five times its weight of water, in a copper vessel, and placed upon the fire. After boiling for a quarter of an hour, the water is decanted, which will have assumed a fine golden yellow colour. We filtre this water through paper, and again put it into the copper vessel, in order to cause it to dissolve what little chromate of potash may still remain in it; we filtre this as before, and repeat the process until the water is no longer coloured yellow.

On the other hand, we dissolve in the nitric acid a certain quantity of mercury: when the solution is effected,

we pour the nitrate of mercury into the solution of chromate of potash, when there will fall a precipitate of a red colour, which is more or less lively, according to the degree of purity of the two solutions; we decant the supernatant water, which ought to be limpid and colourless, instead of yellow, as it at first appeared. We then wash the red deposit which is found at the bottom of the vessel: this is the chromate of mercury.

We proceed as follows, in order to procure the oxide of chrome, which we extract from the chromate of mercury with which it is mixed. We put the chromate, whether dry or not, into a crucible, place it in a furnace, and urge the fire. By this operation the mercury, by reason of its volatility, escapes from the composition; so that at the end of a quarter of an hour, there only remains the oxide of chrome in the crucible, in the form of a light powder, very much divided, and of a fine green colour.

If you would avoid the loss of the mercury in this operation, you must place the chromate of mercury in an earthen retort, to the beak of which an adopter must be luted, with its recipient, in order to condense the mercurial vapours.

If you would not obtain the green oxide of chrome by the distillation of the mercury, you may procure it directly by mixing the chromate of potash with double its weight of flour of sulphur, and subliming it over the fire. In this operation the sulphurets and the sulphites of potash are formed, which may be dissolved out by hot water, and the oxide of chrome be set at liberty. In this last manner the green colour may be extracted from the chromate of iron; and we believe the process is performed by many persons.

This oxide of chrome is very fixed; it bears the great heat of a porcelain furnace without being neutralized; and it can thus be successfully employed to make the plain foundations of the vases intended to be decorated with gold. The tints of green may be varied at pleasure, either by the addition of a little blue, or a little yellow. These

colours are but rarely vitrefied before using them, which renders them exceedingly easy to spread with the pencil.

Of yellow coloured enamel.—This is also a primitive colour, and is procured from several metals, such as antimony, lead, tin, and also silver. The following is the mode of procuring the oxide of antimony, which serves as the basis of a yellow colour of different tints.

They reduce the regulus of this metal to a very fine powder, and pass it through a sieve; they also pulverize the crystallized nitrate of potash (or the nitre of commerce;) they then take one part of the regulus of antimony, and one part and a half of nitrate of potash, and mix the two ingredients intimately; they then place a crucible, formed of good clay, in a furnace, with a good draught, and project into it, a little at a time, the mixture of antimony and nitre. At each spoonful of the matter introduced into the crucible, there is a considerable movement of the mass exhibited; this motion is accompanied by a vivid and brilliant flame; this is extinguished by adding a new quantity of the matters; and the process is continued until the crucible is become nearly full, when it is covered, and a brisk fire is kept up for a quarter of an hour. At the end of this time the crucible is withdrawn from the furnace, broken, and the heavy mass detached which adheres to it; this is pulverized, ground with water on a glass slab, and then placed in a porcelain vessel, where hot water is poured upon it many times. Thus the excess of potash is washed out, and the white oxide of antimony remains at the bottom of the vessel; this is termed washed diaphoretic antimony.

When we would fix this yellow colour by fire, we combine, with one part of this oxide of antimony, one or two parts of the red oxide of lead, or minium, and mix the two oxides perfectly; we then place them in a crucible, and introduce it into a laboratory furnace; we give it a slight degree of fire, but continue it for three quarters of an hour, after which we withdraw the crucible, break it, and find the mixture converted into a fine rich yellow colour.

We can easily, by the same means, obtain yellows, more or less coloured; it is sufficient to know, that for this end, the more the oxide of lead predominates, the paler will the colour of the yellow be.

We can also prepare a very beautiful yellow colour by mixing in a similar manner, with one part of the white oxide of antimony, a part and a half of the acetate of lead (white lead), and one part of the hydrochlorate of ammonia. We pulverize these substances, sift them, and put them upon a test, which we place in a calcining furnace, and make a fire sufficiently intense to decompose and sublime the hydrochlorate of ammonia. When we perceive that the operation is terminated, which is manifested when not an atom of smoke rises; and the composition also appearing of a yellow colour; we withdraw it from the fire, leave it to cool, and wash it in a large quantity of water.

We can also form another yellow with two parts of the white oxide of tin, one part of minium, one part of the sulphate of alumine, and half a part of the hydrochlorate of silver, which the older chemists termed *lunacornea*.

(*To be continued.*)

LXXX.—*On the originators of Gas Lighting in England and France. By* William Matthews, *Engineer.*

It has been stated, since the death of Mr. F. A. Winsor, that he was the "originator of the practical and useful application of gas-lights;" and, likewise, "in 1803 he publicly demonstrated the use to which this chemical discovery was applicable;" but these operations are unauthorized either by the date, circumstances, or even Mr. Winsor's own detail of his discovery. He obtained his patent in May, 1804, and the first magnificent proposal of his scheme to the public is dated in that year, with the following pompous title:—"Account of the most ingenious and important national discovery for some ages. British imperial light ovens and stoves, by which above 1,000 per cent. are saved and gained in light, heat, and some other valuable

products for British manufactures, commerce, and navigation, as proved by an exact account of profit and loss applied," with more matter of similar import, "by F. A. Winsor, the second inventor and improver." Though Mr. Winsor described himself as the second inventor, in the same publication he stated that "the celebrated French engineer, Le Bon, who, on the most flattering representations from the National Institute, obtained the longest *brevet d' invention* ever granted, had, in the winter of 1802, a house fitted up in Paris, which was seen by thousands with the greatest astonishment. The fame of this discovery spreading in all the literary journals of the continent, induced the writer (Mr. Winsor) to travel from Frankfort to Paris, where he often witnessed the wonderful effects of common smoke being made to burn with greater beauty than wax or oil!" But still further to attract attention to what he called his "British imperial patent stoves, ovens, and utensils, for producing sevenfold heat, and beautiful light, oil, pitch, coke, and pure inflammable gas, without sparks, soot, or ashes, from which all the accidents of fire arise;" he annexed the following remarkable advertisement:—"Such noblemen, gentlemen, public or private companies, or individuals, who, from witnessing the uncommon effects of common smoke, shall be convinced of the great utility of this discovery, and may have an inclination to embark some property in this valuable speculation, may be furnished with a sight of a written plan for a three-fold grand national establishment, which, in the least prospect of success, must ensure unexampled advantages to the proprietors, and which opens still greater prospects." Such were the first pretensions and representations of the second inventor of gas-lights; and in the latter part of the year 1804, Mr. Winsor certainly made an exhibition of his "discovery and invention," at the Lyceum. But, in 1805, he published a circular, to display the "immense advantages" of his project, in which he averred, that "five pounds deposit will suffice for realizing the scheme in London and its environs, and all the other sums wanted will

prove a small deduction from speedy profits." In the same letter he also mentioned his "greatly undervalued estimates;" and designated his scheme as "a mine of wealth;" but the acme of his rhodomontade appeared in 1807, when he stated the "savings" to be effected at 114,845,294*l.*; and, "if only one-tenth of this sum were realized, each five pounds deposit will secure 570*l.* per annum." However, to insure to his subscribers the immense advantages held out to them, he proposed that government should impose a tax upon coal, in order to promote the use of his gas and coke; and, according to his estimate, this tax would produce a revenue of 10,751,000*l.* By stories so extravagant did Mr. Winsor, at one period, amuse the public; and it has been affirmed that he did not obtain less than 50,000*l.*, which he expended upon his schemes. That he was "the founder of the chartered gas-light and coke company" is undoubtedly true; and the above extracts will show some of the means by which he effected his purposes; but I believe not the slightest trace exists either of his scientific discoveries, or his mechanical ingenuity and skill, numerous as are the proofs of the great loss sustained by individuals who confided in his representations.

A French *brevet d' invention* being similar to an English patent, that describes the particulars of the invention for which it is granted; it may be fairly inferred that Mr. Winsor actually read M. Le Bon's while he was in Paris; and it is remarkable, that although on the first application for a bill to incorporate the gas-light and coke company, in 1809, one of the principal reasons alleged was the grand discovery alluded to above, which was also strongly maintained by the notorious Accum (Mr. Winsor's coadjutor), yet, on the second application, in 1810, the very petitioners for the bill positively affirmed, that "the persons applying for it have never claimed the merit of original invention in the application of gas-lights!"

That Mr. Murdoch, engineer to Messrs. Boulton and Watt, of the Soho, near Birmingham, was the person who

first made gas-light extensively useful, and long before Mr. Winsor knew any thing about them, has been established by the incontrovertible evidence of facts. In 1792, he employed them to light his office at Redruth, in Cornwall, where he also amused the inhabitants by a small steam-carriage, which ran along the roads with gas-lights attached to it. In 1798, he introduced their use to light Messrs. Boulton and Watt's steam-engine manufactory at the Soho; and, at the celebration of the peace, in April, 1802, the illumination of Messrs. Boulton and Co.'s very large establishment was wholly with gas-lights, which was the first public display of this mode of illumination in any country. This splendid exhibition, at the Soho, I saw, and probably 100,000 persons besides myself; it was continued for several successive nights, and was reported in the newspapers of the time. Mr. Clegg, the inventor of the gas-meter, and the present engineer to the imperial gas-light company, being then an apprentice to Messrs. Boulton and Watt, assisted in the operation; and this evidently occurred many months prior to M. Le Bon's exhibition at Paris, which Mr. Winsor stated that he "travelled from Frankfort to Paris" to witness. The establishment at the Soho occupies a space nearly as large as Greenwich Hospital, so that some opinion may be formed of the extent of the application of gas-lights before Mr. Winsor went to Paris, or exhibited at the Lyceum, or in Pall-mall. Besides, the chartered company did not succeed till they discarded Mr. Winsor's plans, and adopted those which Mr. Murdoch had introduced.

In my "Historical Sketch of the Origin and Progress of Gas-lighting," I endeavoured to give a faithful narrative of Mr. Winsor's labours; and I trust that those who may have dispassionately read that little work, will admit my having candidly and justly appreciated his merits, studious

——— "Nothing to extenuate,
Nor set down aught in malice."

This letter is dictated by the same regard for truth and

rectitude; and should you favour me with its insertion, it may enable your readers to form their own opinion of the correctness of my statements, though they may be in direct contradiction to the erroneous and fallacious account sent to you by some indiscreet and not very well informed admirer of the late Mr. Winsor.

With respect, I am, &c.
WILLIAM MATTHEWS.

London, May 20, 1830.

Remarks, by the EDITOR.

We have transcribed the above from one of our respectable daily journals, and entirely agree in the sentiments expressed by Mr. Matthews, as to the demerits of the late Mr. Winsor, some of whose lectures we attended both at the Lyceum and in Pall-mall, and were not a little amused at the extravagence of his pretensions, and the ignorance he displayed in real science; for instance, at the Lyceum, he pretended to smelt metals by means of gas. Now, what will our readers think, when we tell them, that this pretended smelting of metals consisted merely in fusing soft solder, contained in an iron ladle, over the flame of the gas, an operation which does not require more heat than is sufficient to boil water! We also well recollect his complete failure in his attempt to light Pall-mall by means of gas, although his apparatus was stationed most favourably for the purpose. And likewise, that when he attempted to light the back of Carlton-house gardens, in St. James's-park, the gas stunk so abominably, owing to its want of due purification, that Mr. Winsor declared, some enemy of his must have scattered assa-fœtida all along the front of the wall!

We think that some notice is due to the early efforts made by the late Mr. Knight, a watchmaker, formerly residing in Fleet-street, near to Fetter-lane, in gas-lighting. We well recollect the success of his endeavours to light his own premises, and we may also add, that he was the first establisher of the Dorset-street, or City gas-works, and which still hold their eminence in this respect amongst their numerous rivals.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since April 24, 1830,

To John M'Innes, of Auchenreoch, and of Woodburn, in that part of our united Kingdom of Great Britain and Ireland called Scotland, Esq.; for the manufacture or preparation of certain substances which he denominates "British Tapioca," and the cakes and flour to be made from the same. Dated April 24, 1830.—To be specified in six months.

To Samuel Brown, of Billiter-square, in the city of London, commander in our royal navy; for certain improvements in making or manufacturing bolts and chains. Dated April 24, 1830.—In six months.

To Joseph Cochaux, of Fenchurch-street, in the city of London, merchant; who, in consequence of a communication made to him by a certain foreigner residing abroad, is in possession of an apparatus calculated to prevent or render less frequent the explosion of boilers, in generating steam. Dated April 24, 1830.—In six months.

To Paul Descroizilles, of Fenchurch-street, in the city of London, chemist; for certain improvements in apparatus for economizing fuel, in heating water and air, applicable to various purposes. Dated April 24, 1830.—In six months.

To Thomas Cook, of Blackheath-road, in the county of Kent, lieutenant in our royal navy; for certain improvements in the construction and fitting up of boats, of various descriptions. Dated April 24, 1830.—In two months.

To James Perry, of Red Lion-square, Holborn, in the county of Middlesex, bookseller and stationer; for an improvement or improvements in or on Pens. Dated April 24, 1830.—In six months.

To John Wilkes, of Blue Anchor-road, Bermondsey, in the county of Surry, engineer, millwright, and machinist (one of the co-partners in the firm of Bryan Donkin and Co., of the same place, engineers, millwrights, and machinists); for an improvement or improvements in a part or parts of the apparatus for making paper by machinery. Dated April 28, 1830.—In six months.

To Thomas Petherick, of Penfullick, in the parish of Tywardreath, in the county of Cornwall, mine agent; for certain machinery for separating copper, lead, and other ores, from earthy and other substances with which they are or may be mixed; and which is more particularly intended to supersede the operation now practised or used for that purpose, commonly called jigging. Dated April 28, 1830.—In six months.

To John Walker, of Weymouth-street, in the county of Middlesex, esq.; for an improved cock for fluids. Dated May 4, 1830. —In two months.

To Henry Robert Salmon Devenoge, of Little Stanhope-street, May-fair, in the county of Middlesex, gent.; who, in consequence of a communication from a foreigner residing abroad, is in possession of certain improvements of machinery for making bricks. Dated May 8, 1830.—In two months.